WAGNER FREE INSTITUTE OF SCIENCE
of PHILADELPHIA

PUBLISHED BY THE INSTITUTE

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Carl Boyer, Curator

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ANNOUNCEMENT

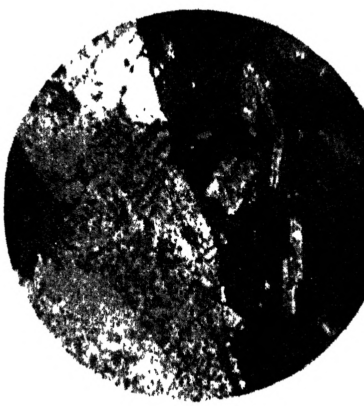
With this issue, the Wagner Free Institute of Science of Philadelphia begins the publication of a Bulletin announcing the results of scientific investigations under its auspices and reports of educational work. The Institute owes its founding to the liberality and public spirit of William Wagner and his wife, Louisa Binney Wagner. In early life Professor Wagner made many sea voyages, visited scientific institutions and made acquaintance of scientific workers. He developed a strong interest in science, especially geology and mineralogy, and gave much attention to studying these and collecting illustrative material.

In 1847 he began giving free lectures in his home near the present location of the Institute. In 1855 the Institute was incorporated by the Legislature, a faculty appointed and regular lectures given. In 1865, the present building was finished, since which time scientific work by means of lectures, publications and museum instruction has been carried on uninterruptedly. All opportunities are offered freely to the public. The Trustees, fully aware of the importance of research, have made grants for carrying on such work. In addition to such information as will be furnished in the Bulletin, the transactions of the Institute appear from time to time reporting more elaborate investigations. A list of the Trustees and Faculty appears elsewhere in this issue, and full information on all activities is given in the Annual Announcement, a copy of which will be sent on application.

MUSEUM NOTES

The Institute Museum has among its most interesting specimens two large rock masses that have been placed on either side of the main entrance so as to be on view to the passers-by. One is a fossil stump weighing several hundred pounds from Gilboa, N. Y., being one of the specimens of a fossil forest that was discovered in the course of excavations for the water supply of New York City. The forest is of Devonian date and, therefore, very old. The trees are of the general nature of ferns. Sections of the stump have been made, but these show only faint indications of vegetable structure. In this point they differ materially from the sections of petrified trees from Arizona, of which the Institute has a number of fine specimens, including one that is thought to be a pine cone. Analysis of the fossil stump showed a high percentage of silica with a minute amount of organic matter.

The other specimen displayed at the Institute entrance is a block of granite (diorite) penetrated by a dike of diabase about 4 inches wide. The dike is jet black and contrasts strongly with the granite matrix. A section has been made so as to include both the granite and the dike material, and the illustration herewith shows a microphotograph made with the Institute equipment.



Section at line of contact between granite and diabase. The latter came up fluid through the crevice in the granite, but before becoming solid crystals of felspar separated, shown in the right side of the view. The granite shows no similar structure. Photomicrograph by Henry Leffmann. Magnification about 10 times.

During recent years, by exchange, additions have been made to the herbarium from New Zealand, South Africa, Australia (N. S. W. and S. A.), England, Wales and France. Two interesting additions have been received from Miss M. A. Pope, Assistant Curator of the Colorado State Museum, being specimens of *Kochia scoparia* and *Salsola pestifer*, plants occurring in the neighborhood of Denver and active as causes of hay fever.

MUSEUM TALKS

Under this title the Institute has conducted for a number of years informal instruction by members of the Faculty and other specialists utilizing the museum specimens for illustration. The museum is excellently provided and arranged for such purposes which may be termed "applied natural history." They are arranged for each month from November to March, both inclusive. Postal card notices will be sent to all who forward to the Institute a request for information.

RESEARCH LABORATORY NOTES

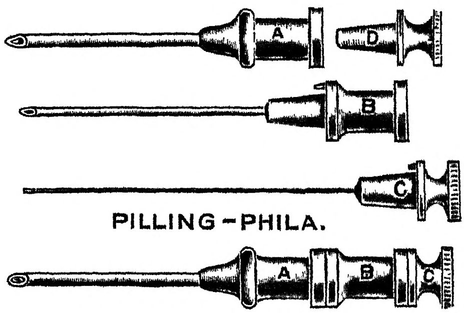
Duriron as the Negative Element of a Voltaic Couple.—Duriron is an iron silicid containing about fifteen percent. of silicon. It is highly resistant to corrosive agents, and is extensively used in chemical industries. It seemed possible that it might be used as a substitute for carbon in the ordinary chromic-sulfuric acid battery, which was much used before electricity became commercially available. It gives a powerful current for a moderate time, but the carbon plates being more or less porous absorb the salts formed. No ordinary metal will withstand the corrosive action. The Duriron Manufacturing Company, of Dayton, Ohio, kindly furnished a cell of the material about ten inches high and four inches in diameter (internal measures). A porous cell and a bar of zinc was obtained. The zinc was as usual in contact with dilute sulfuric acid, while in the outer cell was the chromic-sulfuric mixture. This does not set on the duriron. Tests showed a current of 2 volts, 2 amperes. A better result would have doubtless been obtained if a series of plates of the duriron and amalgamated zinc had been used. The apparatus has naturally comparatively little interest at present, owing, as noted above, to the availability of the electric current, but inasmuch as almost all installations for commercial purposes are changing to alternating current, it may be well for lecturers to have some such apparatus for occasional use in illustrating electrolytic phenomena.

Comparison of the Vanillin and Rothera Test for Acetone.—In clinical work the Rothera test (nitroprussi, ammonium sulfate and ammonia) is much in favor, but lately Mr. Trumper, assistant in the research laboratory, has been making some comparisons of it with the vanillin test. The latter is of very easy application. A small amount of the liquid to be tested is mixed with some strong alcoholic solution of vanillin in a test-tube and a fragment of sodium hydroxid dropped in. Acetone is promptly shown by a red ring which deepens rapidly and persists for a long while. The Rothera test fades out soon and is further found to be quite unsatisfactory in presence of albumin, but the vanillin test is still satisfactory under this condition.

TRUMPER TELESCOPIC NEEDLE

In many functional or tolerance tests (glucose, urea), involving the introduction into and absorption from the alimentary tract of the test substance, the variable rate of absorption may interfere with the accuracy of the test. This may be avoided by introducing the test substance intravenously.

Blood Volume studies and functional tests which necessitate the repeated venous puncture for blood sampling (vital red, phenoltetrachlorphthalein) are occasionally objectionable to the patient and there may be difficulty in entering the vein at regular stated intervals.



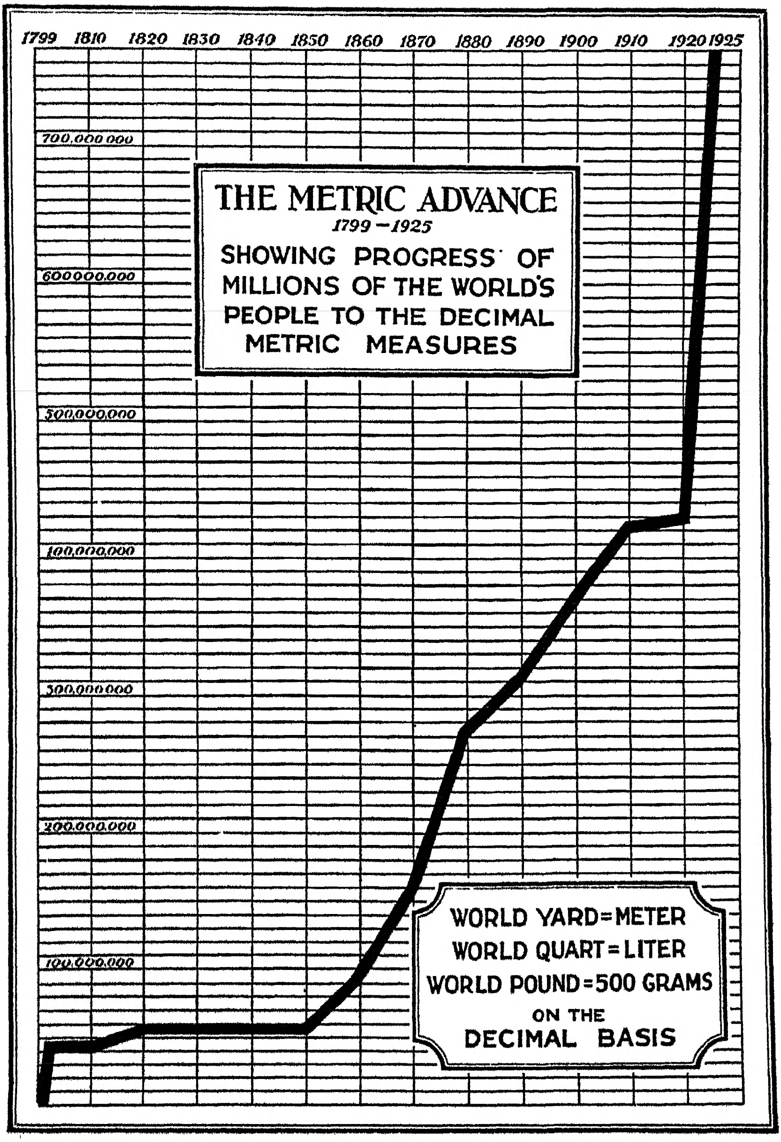
Trumper Telescopic Needle.

These difficulties may be overcome by the use of the telescopic needle shown herewith. The needle consisting of A, or A and B, is introduced and control sample of blood withdrawn. In children or in patients with very small veins A may be dispensed with. If desired, the flow of blood may be stopped by occluding the lumen with B and C, or C alone if A is not used.

When the test solution is to be introduced, stylette C is withdrawn and reintroduced when the desired quantity of fluid has entered the vein. If B alone has been used, before introducing C the needle is flushed, either by allowing 2 c.c. of blood to flow out or introducing a few c.c. of sterile salt solution. The needle may be held in position by placing a gauze sponge over both ends and fixing with strips of adhesive or narrow bandage. If the patient is restless the arm may be immobilized by a straight splint. Subsequent samples are obtained by withdrawing B and C, the blood flowing out through A.

It is my belief that the needle may be allowed to remain in the vein for an hour but thus far I have only used it for periods extending up to 25 minutes during which time three samples of blood have been withdrawn. The danger, if any, lies in the possibility of forcing particles of a blood clot into the vein when stylette C is repeatedly withdrawn and introduced. This matter is now under investigation.

This telescopic needle has been in use in the Jefferson Hospital since September, 1923.

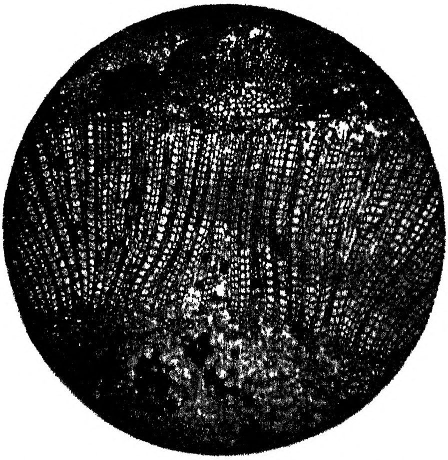


Courtesy of the Franklin Institute.

Issued by the Central Manufacturing District of Chicago, based on data furnished by the All-American Standards Council of San Francisco.

THE NATURE OF COAL

The acuteness of the fuel problem attracts attention to the nature and origin of solid fuel. It is conceded that it is the result of slow oxidation of vegetable matter by which oxygen is removed and the carbon and mineral matter remain. The progress of the change can be traced in deposits in different parts of the world. Peat, which is an early stage, is obviously vegetable. Lignite, brown coal, bituminous, semi-bituminous and anthracite are the later stages in succession. The best anthracite, such as found in the Pennsylvania mines, consists of little else than carbon and mineral matter. It constitutes an excellent fuel for domestic purposes as well-known. In the anthracite region abundance of plant impressions are found. They are characteristic fern forms. The softer coals, however, show the remains of plant structure much more definitely, often preserving the most minute details. Much research has been carried out on this line and many striking specimens obtained. It has been found that pollen and the spores of ferns and their allies have been often converted into coal. The Lancashire district in England is rich in remains of coal plants and below is shown a photomicrograph of a specimen in possession of the Institute, being a section of a nodule from the Lancashire mines.



Section of portion of stem of Lyginodendron oldhamii from coal flora of Lancashire, Eng. Lyginodendron is a term from the Greek and means "willow tree," but the plant is not in any sense a "willow," but more of the nature of a fern. Photomicrograph by Henry Leffmann. Magnification about 10 diameters.

WESTBROOK LECTURES FOR 1926

By the liberality of Richard Brodhead Westbrook, D.D., for many years a trustee of the Institute, and his wife, Henrietta Payne Westbrook, provision has been made for lectures independent of the general courses and covering a wide range of topics. The first course was delivered in 1912 by Dr. Morris Jastrow, on "The Ancient Civilization of Babylonia and Assyria," and courses have been given in each succeeding year. The lectures are delivered in the Hall of the Institute and are free to all persons interested.

RICHARD B. WESTBROOK FREE LECTURESHIP

ANNOUNCEMENT AND SYLLABUS OF THE COURSE FOR 1926

Hall of the Wagner Free Institute of Science.

Montgomery Avenue and Seventeenth Street, Philadelphia

Friday, March 19 and 26; Saturday, March 20 and 27, at 8 P. M.

GEORGE HOWARD PARKER, B.S., Sc.D.

Professor of Zoology and Director of the Zoological Laboratory, Harvard University

The Animal Mind: Its Sources and Evolution. Illustrated.

First Lecture—Friday, March 19, at 8 P. M.

Animal activities as signs of mind:

Effectors and their action. Urtication. Secretions, external and internal. Animal Light. Color Changes. Movements: ameboid, ciliary, muscular. Animal Electricity. Behavior.

Second Lecture—Saturday, March 20, at 8 P. M.

The Senses and Mind:

Kinds of Senses. Receptors versus Sense Organs. Chemical Reception: smell, taste, pain. Mechanical Reception: touch, pressure, hearing. Reception of Radiation: temperature sensation, sight. Sensory Patterns and Distribution.

Third Lecture—Friday, March 26, at 8 P. M.

The Animal Mind:

Its Beginnings. Diffuse Condition: nerve-nets, autonomous organs. Centralization: nerves and ganglia, synaptic systems. The Central Organ: In simple animals; in complex animals.

Fourth Lecture—Saturday, March 27, at 8 P. M.

The Animal Mind (concluded):

Muscle: sense organ and central organ. Reflexes. Tropism. Intelligent Acts. Instinct and Habit. Central States and the Bodily Environment. Memory. Volition. Ultimate Explanations.

WAGNER FREE INSTITUTE OF SCIENCE

Montgomery Ave. and Seventeenth St., Philadelphia, Pa., U. S. A.

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Henry Leffmann, A.M., M.D., Ph.D.	Chemistry
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CARL BOYER, Curator

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ANNOUNCEMENTS

THE lecture course for 1925-6 at the Institute was formally closed on Wednesday, May 12, 1926. Certificates for satisfactory work in the several departments were awarded and full course certificates for attendance on the entire series of lectures as provided in the curriculum. Details of the exercises and a list of certificates awarded are given on page 10 of this issue. The lecture courses will be resumed in September. Full information concerning these will be found in the annual Announcement which will be issued in August next and will be sent on application.

Apart from the notice of the closing exercises and the official list of the Institute, this issue of the BULLETIN is occupied entirely with a paper by Messrs. Grier and Mueller, being a contribution from the U. S. Biological Laboratory at Fairport, Iowa. The paper deals with the modifications of fresh-water mussels under the influence of environment. In view of the present interest in the data of evolution and the relative influence of heredity and environment, the contribution is opportune. Owing to its extent, it has been decided to make the present issue of the BULLETIN a double number, covering the issues of May and July. The next issue will be for September and is expected to appear early in that month.

CLOSING EXERCISES OF THE LECTURE COURSES FOR 1925–6

The closing exercises of the lecture courses for 1925–6 were held on Wednesday, May 12, 1926, at 8.15 P. M., in the hall of the Institute.

Professor Samuel C. Schmucker, president of the faculty, presided, and after brief introductory remarks announced the names of the students who had completed the requirements and were entitled to receive certificates, which were awarded.

Dr. Henry Leffmann delivered an illustrated lecture on "Coal and Coal Mining."

The following certificates were awarded:

Full Term (4 courses) Certificates

Norman J. McDonald
Mrs. Norman J. McDonald, Botany
Milton K. Meyers, Physics

1925–6 CERTIFICATES

ENGINEERING 3

Abraham Agatstein
Emanuel Hocking
William Hain Lengel
Andrew M. Pataky
Charles H. Seidel
Joseph Spike

ZOOLOGY 3

Nicholas Cianfrani
Walter F. Estlack
H. May Hunter
Milton K. Meyers

INORGANIC CHEMISTRY 1

L. Coggin
Charles Cohen
Frank E. Draper
Abraham Josel
William Josephs
Milton K. Meyers
David Peters
M. Tubis

ORGANIC CHEMISTRY 1

L. Coggin
Charles Cohen
Walter F. Estlack
Alvin A. Krauss
William Josephs
Abraham Josel
Milton K. Meyers
David Peters
M. Tubis

BOTANY 3

Frank E. Draper
H. May Hunter
Mrs. N. J. McDonald
Norman J. McDonald
Milton K. Meyers
Hugh F. Munro, Jr.
Mrs. Thomas H. Peacock
Ardella G. Styer

PHYSICS 4

J. A. Devine
John Hoffmann
Raymond McClintock
Milton K. Meyers
Sarah Peartree
Victor H. Sparrow, Jr.

GEOLOGY 3

Frank E. Draper
George F. Faust
Leonard D. Frescoln
Katherine R. Guest
Alfred D. Hills
D. B. Johnson
Milton K. Meyers
Sarah Peartree
Harold Poole
C. H. Wolff

FURTHER STUDIES IN CORRELATION OF SHAPE AND STATION IN FRESH WATER MUSSELS*

By N. M. Grier† and J. F. Mueller
(Dartmouth College) (University of Illinois)

Various students of the Naiad shells have commented upon the fact that the same species may assume different forms in response to different environments. Ortmann,[13] with Ball,[2] lists 22 species groups of mussels, in each of which the flatter and less inflated form is found in the tributaries and the upper part of the stream, while the more swollen shells are in the lower stretches of the river. Where these upstream forms had previously been considered distinct species, Ortmann's researches showed them to intergrade with the downstream shells and they were reduced to the rank of varieties. These observations of Ortmann's for many of the species are confirmed by those of Utterback,[17] Danglade,[4] Wilson and Clark,[19] and Meek and Clark.[11]

Ortmann further found that a loss in diameter in the headwaters was compensated for by a gain in size and circumference (as best expressed by the total length of the shell), but he makes it clear that in 12 species at least he could detect no evidence of a compressed form peculiar to the tributaries and an inflated form found further downstream. This paper will present two exceptions to his findings. Isely [9, 10] observed that peculiarities of distribution are very probably to be traced back to the young shells which are mostly carried about by fish and are thus subjected to varied conditions which are potent in determining the character of the adults. This point was taken in account by Ortmann, who mentions the possibility that compressed and inflated forms of the same species are the consequence of reaction to local environmental conditions. Where, however, the larval stages are carried by more stationary, rather than migratory, fishes, he believes that the development of local races, in consequence of reaction to local environmental conditions, is favored. In the cases where migratory fishes are the hosts, he thought no such local development was possible, any tendency toward it being promptly obliterated by the mixing of different stocks. This may account for the behavior of certain species which do not react in the manner described.

* Contribution from the United States Biological Laboratory, Fairport, Iowa. Published by permission of Commissioner of Fisheries, Washington, D. C.

† Paper presented before Ecological Society of America, Washington, 1924.

The preceding comprises a summary of the literature immediately pertinent. For the benefit of those who are further interested in the variation of fresh water mussels, it is remarked that most of this literature, including that of European investigators, has been reviewed by Grier[6] and Ball.[2]

While engaged in mussel survey and appraisal work for the U. S. Bureau of Fisheries on the Upper Mississippi River region, we had the opportunity of observing the variations of fresh water mussels in what will be seen to represent four sharply differing types of environments. The headings under which they will be discussed are the Mississippi River above Lake Pepin (upper river), Lake Pepin, the Mississippi River below Lake Pepin (lower river), and the sloughs adjacent to these bodies of water. The underlying physiographic conditions may be summarized briefly, following Galtsoff:[5]

"Between St. Anthony Falls and the mouth of the Ohio the Mississippi flows in the narrow flood plain between steeps and bluffs forming its gorge. The river winds from one side of the flood plain to the other, numerous islands dividing the channel and forming many sloughs and bogs which are often transformed by the sandbars into pools of stagnant water. In the northern part, about 52 miles below St. Paul, the river fills out its gorge, covering the whole flood plain from bluff to bluff, forming the so-called Lake Pepin, which covers an area of 38½ square miles and has a depth of about 35 feet. Lake Pepin owes its origin to the Chippewa River, a small tributary entering the Mississippi from the east; the delta of the Chippewa extending into the main stream lies at the south end of the lake, and is now covered with modern flood plain deposits. It has dammed the Mississippi, leaving a narrow outflow opposite Read's Landing, and the river above the delta has overflowed its banks and filled out the whole gorge. At the northern end of Lake Pepin the Mississippi has built its own delta, which is still growing. It has reduced the inlet of the lake to a narrow stream less than 1,000 feet in width, while the outlet above the mouth of the Chippewa is 1,400 feet in width. The northern part of the lake is now very shallow and is almost entirely filled with sand and silt. Bluffs and terraces form the shores of the lake on the low shore lines while, especially on the Minnesota side, the waves and currents have deposited sand and have formed spits. The fall of the river from Red Wing, about five miles above the head of the lake, to Read's Landing, on the outlet 28 miles below, is only .02 feet per mile. In the middle part of the lake there is no fall of water at all. At the foot of the lake above the mouth of the Chippewa the slope is 0.25 foot per three miles, while just below Read's Landing it is 1.65 feet per three miles."

Lake Pepin is seen to represent what is more accurately termed a *river lake:* lake-like in that it represents a body of relatively still water, but yet intimately connected with the river. Says Coker,[3] "With the opportunity for the internal circulation, plankton conditions and community life corresponding in some degree to typical lakes, there are combined in a measure the features of circulation and regular renewal of water corresponding more nearly to usual river conditions."

Now, as is well known, lake and river forms of the same mussel

are frequently quite different in character, as pointed out by Walker.[18] Lake forms in general are shorter, have a higher degree of inflation, more regular lines of growth, a polished epidermis, and somewhat of a depauperate aspect. It is rare also for a lake to produce shells of such thickness and form as to be useful for button making, but Coker states, in the instance mentioned (Lake Pepin), "We find, however, characteristic river mussels and, what is more striking, we find that a species such as the fat mucket (*Lampsilis siliquoidea* Barnes), which is generally abundant and worthless in true lakes, is in river lakes abundant and valuable. Are its good qualities attributable to the unusual combination of river and lake conditions, or are they characteristic of a geographic region?" A paper by Baker,[1] portions of which are now cited, is of interest in this connection:

"Lake Winnebago is . . . really a widened out portion of the Fox River. . . . One of the most interesting features brought out by the study of the molluscan fauna of the Lake Winnebago region is the difference in size and shape between the *Unionidæ* (Naiades) of the Fox River and those of the lake, a difference which seems comparable to that noted by Grier (1920), between the Naiads of Lake Erie and the upper drainage of the Ohio River. Grier states, 'if we put a shell into the lake environment we may expect it will change its morphological features, not at random, but in a distinct, determinate or orthogenetic direction.' This change in the morphology of shells which have migrated from a river to a lake is strikingly shown in the Lake Winnebago fauna and study of the two areas by the methods of Grier would produce the same results as attained by the study of Lake Erie shells. It is to be noted as a significant fact that the same varietal forms inhabit both Lake Winnebago and Lake Erie, indicating that the law holds good under similar conditions in widely separated areas." After pointing out the effects of the lake environment on other types of molluscan life Baker finally states, "the entire molluscan fauna is affected by the same law of variation produced by river and lake environment, clearly indicating that ecological station plays a large part in the evolution of species. . . . Just what factors have been potent in producing these changes does not seem to be definitely known. It is probable that variation in food supply, in the chemical character of the fluid medium in which they live as well as in the general physical environment, plays a large part in these changes of form." It is of interest to the authors that while they had collected the data forming the basis of this article four years before Baker published his article, the latter anticipated to a large extent their conclusions, as may hereafter appear. In fact, they were ignorant of his work until their own manuscript had been drafted.

Limnological data obtained from Galtsoff's paper permit us to qualify our preceding statement as to the distinction in the environments of the Upper River, Lake Pepin, Lower River, and the Sloughs. Observations made by him indicate that the following physical conditions are characteristic of each:

Upper River

Depth.—5–37 feet, but usually varying from 9–15 feet.
Temperature of Water.—Warmer than in lake.
Velocity of Current.—1.38 feet per second one mile above Lake Pepin.
Units of Discharge.—2000 cubic feet per second.
Transparency of Water.—80 cm. Becomes more opaque downstream (sediment).
Bottom Conditions.—Gravel, sand, snags.
Plankton.—21.5 cc. per cubic meter of water.

Lake Pepin

Depth.—35–56 feet, the latter depth occurring only in a small area.
Temperature of Water.—Cooler than in sloughs, upper and lower river.
Velocity of Current.—.9 to .83 foot per second.
Units of Discharge.—8000–127000 cubic feet per second.
Transparency of Water.—19 to 102 cm. (at outlet).
Bottom Conditions.—Smaller gravel, sand, mud; very rocky near outlet.
Plankton.—21.5–33 cc. per cubic meter of water. Greater production at low water stages. Richer in Crustacea and Rotifera. Has additionally all the organisms found in the river plankton.

Lower River

Depth.—5–37 feet, but usually varying from 9–15 feet.
Temperature of Water.—Warmer than in lake.
Velocity of Current.—2.05 feet per second at Read's Landing immediately below the lake, 2.42 between Winona and Homer.
Units of Discharge.—16000–177000 cubic feet per second.
Transparency of Water.—22–79 cm.
Bottom Conditions.—Principally mud and sand, due to construction of wing-dams.
Plankton.—18.5–21.5 cc. per cubic meter of water.

Sloughs

Depth.—Shallower for the most part than any of the preceding.
Temperature of Water.—Higher than in main channel.
Velocity of Current.—Varying between .32 and 1 foot per second.
Units of Discharge.—Less than other habitats.
Transparency of Water.—.27 cm.
Bottom Conditions.—Sand, smaller gravel.
Plankton.—10–18 cc. per cubic meter of water, but under certain conditions richer qualitatively and quantitatively than the main channel.

So far as these different types of environment are concerned, the greatest resemblances between them are seen to lie on the one hand between the upper and lower rivers, and on the other, between the (river) lake and the slough. One difference between the upper and lower river seems to be expressed in the velocity of currents and units of discharge, while the resemblance between the river lake and the slough consists of a somewhat similar velocity of current, transparency of water, bottom conditions and possibly plankton.

The general differences between lake and river mussels of the same species being known, it will be one object of this paper to point out the more commonly observable morphological differences which we have found to exist between the river and river lake forms of the same species of mussel in possible response to the described environments, as well as to ascertain in this peculiarly interesting case the effect on the mussel shells of the interpolated river lake environment between that of the upper and lower river regions. There will also be an attempt to follow the line of attack of previous investigators in an effort to correlate the shape of the mussel with its

geographical location in the river as well as to indicate the more prominent shell characters of the same species when found in sloughs where conditions are largely lake or pond-like, except during the normal high water period of May and June, when a great deal of the drainage passes through them.

Method

The conditions under which we worked in the field permitted us to make but three measurements of each mussel specimen—the length (L); the dorso-ventral diameter, or height (DVD), and the dextro-sinistral diameter (DSD). These measurements were made in centimeters and later resolved to factors for comparison by division into the length. Thus $\frac{DVD}{L}$ expresses the value of the height in terms of the length and $\frac{DSD}{L}$ gives the value of the convexity obesity or degree of inflation of the shell. Such computations were made for the greatest number of shells available from the types of environment already mentioned, and from these results the conclusions are derived. For the fullest information of those who are particularly interested in a study such as this, it is remarked that the shells from the upper river were collected over a distance of 10 miles; from Lake Pepin throughout its length of 28 miles, while those from the lower river were taken over varying distances over 42 miles. In the case of the sloughs most of the material came from those below Lake Pepin and over a distance roughly estimated at 15 miles. The physical conditions make it improbable that the shells found in these sloughs have their origin in Lake Pepin, rather their presence there is to be explained mostly by the fact that they are dropped from the fish in these their spawning and feeding grounds, and have continued to develop there. It is true that some shells may be carried into the sloughs by high water, but this would mostly affect only certain lighter species, such as the paper shells and floaters. Ordinarily, the mussels are pretty well entrenched on the bottom of their habitat.

Results

These are presented in connection with the more modern system of nomenclature of the species studied and with each species is also given its common name. Under the heading of each species will be found the number studied from each type of environment, and the maximum, minimum, and mean values for L, $\frac{DSD}{L}$ and $\frac{DVD}{L}$. From the mean values are plotted the accompanying graphs, which will illustrate more clearly to some the variation in each species in response to the particular environment, and where those environments tend to converge, as in the case of the sloughs and Lake Pepin, the somewhat parallel effect to be observed on certain species. It is unfortunate that in some instances the comparisons have had to be made on an unequal number of specimens, and that the differences resulting in certain conclusions have not been greater. In these cases, however, the conclusions taken are fully supported by further study of the maxima of the measurements.

Sub-family Unioninæ

Quadrula verrucosa (Raf.). Buckhorn

Locality	DSD/L				DVD/L			L		
	No.	Max.	Min.	Mean	Max.	Min.	Mean	Max.	Min.	Mean
Above Lake Pepin....	7	.44	.33	.36	.76	.29	.56	9.6	7.7	8.6
Below Lake Pepin..	13	.38	.31	.34	.64	.54	.58	11.9	7.4	10.3

Amblema peruviana (Lam.). Three ridge

Locality	DSD/L				DVD/L			L		
	No.	Max.	Min.	Mean	Max.	Min.	Mean	Max.	Min.	Mean
Above Lake Pepin....	50	.71	.25	.53	.75	.56	.69	12.2	6.2	8.6
Lake Pepin....	50	.70	.49	.57	1.00	.58	.73	11.	3.8	7.4
Below Lake Pepin....	50	.69	.43	.56	.81	.63	.74	10.2	3.6	6.7
Sloughs............	50	.72	.40	.55	.85	.58	.72	11.9	3.8	6.6

Fusconaia ebenus (Lea). Niggerhead

Locality	DSD/L				DVD/L			L		
	No.	Max.	Min.	Mean	Max.	Min.	Mean	Max.	Min.	Mean
Above Lake Pepin....	9	.80	.66	.71	.84	.74	.79	7.9	6.0	6.78
Lake Pepin..........	..	..	..	..	..	..	..	..	..	..
Below Lake Pepin....	11	.74	.55	.64	.84	.67	.77	10.3	7.4	9.8
Sloughs.............	12	.66	.58	.63	.88	.77	.84	8.8	4.9	6.6

Fusconaia flava undata (Barnes). Pigtoe

Locality	DSD/L				DVD/L			L		
	No.	Max.	Min.	Mean	Max.	Min.	Mean	Max.	Min.	Mean
Above Lake Pepin....	20	.93	.75	.86	.83	.56	.74	7.9	5.8	6.95
Lake Pepin..........	50	1.4	.57	.72	1.3	.73	.97	6.6	1.6	4.52
Below Lake Pepin....	50	.79	.55	.69	.99	.79	.86	7.3	2.7	4.76
Sloughs.............	50	.89	.58	.69	1.09	.68	.87	7.0	2.5	4.93

Plethobasus cyphyus (Raf.). Bullhead

Locality	DSD/L				DVD/L			L		
	No.	Max.	Min.	Mean	Max.	Min.	Mean	Max.	Min.	Mean
Above Lake Pepin....	..	..	..	..	..	..	..	..	..	..
Lake Pepin..........	..	..	..	..	..	..	..	..	..	..
Below Lake Pepin....	13	.64	.33	.53	.75	.49	.69	11.6	6.2	8.7
Sloughs.............	13	.78	.50	.56	.72	.65	.69	9.7	4.1	6.8

Elliptio dilatatus (Raf.). Spike

Locality	DSD/L				DVD/L			L		
	No.	Max.	Min.	Mean	Max.	Min.	Mean	Max.	Min.	Mean
Above Lake Pepin....	3	.39	.31	.34	.48	.46	.47	12.9	9.9	11.25
Lake Pepin..........	23	.39	.22	.33	.54	.45	.51	9.4	6.1	7.7
Below Lake Pepin....	24	.40	.27	.33	.62	.44	.49	11.9	7.2	9.35
Sloughs.............	6	.45	.32	.38	.54	.46	.50	11.4	5.9	9.56

SUB-FAMILY ANODONTINÆ

LASMIGONA COMPLANATA (Barnes). White Heel Splitter

Locality	$\frac{DSD}{L}$				$\frac{DVD}{L}$			L		
	No.	Max.	Min.	Mean	Max.	Min.	Mean	Max.	Min.	Mean
Above Lake Pepin....	9	.26	.15	.21	.69	.56	.59	17.0	9.2	14.0
Lake Pepin..........	23	.37	.19	.26	.73	.55	.64	15.4	7.05	10.7
Below Lake Pepin....	6	.28	.20	.24	.72	.60	.65	14.9	8.9	11.63
Sloughs.............	5	.31	.25	.29	.73	.62	.68	15.9	12.5	13.6

ANODONTA CORPULENTA (Cooper). Floater

Locality	$\frac{DSD}{L}$				$\frac{DVD}{L}$			L		
	No.	Max.	Min.	Mean	Max.	Min.	Mean	Max.	Min.	Mean
Above Lake Pepin....	..	..	..	..	..	..	..	..	..	..
Lake Pepin..........	32	.62	.35	.42	.85	.60	.71	12.9	6.9	9.5
Below Lake Pepin....	32	.54	.32	.43	.72	.56	.64	13.2	7.5	10.5
Sloughs.............	32	.48	.37	.42	.70	.58	.63	14.1	6.2	10.2

STROPHITUS EDENTULUS (Say). Squaw Foot

Locality	$\frac{DSD}{L}$				$\frac{DVD}{L}$			L		
	No.	Max.	Min.	Mean	Max.	Min.	Mean	Max.	Min.	Mean
Above Lake Pepin....	4	.44	.38	.40	.60	.57	.58	9.4	7.9	8.6
Lake Pepin..........	15	.47	.17	.42	.74	.56	.62	7.11	4.7	5.75
Below Lake Pepin....	15	.48	.26	.34	.69	.48	.52	11.17	4.6	8.0
Sloughs.............	12	.48	.35	.44	.62	.52	.58	11.2	4.7	7.7

SUB-FAMILY LAMPSILINÆ

OBLIQUARIA REFLEXA (Raf.). Three-horn warty back

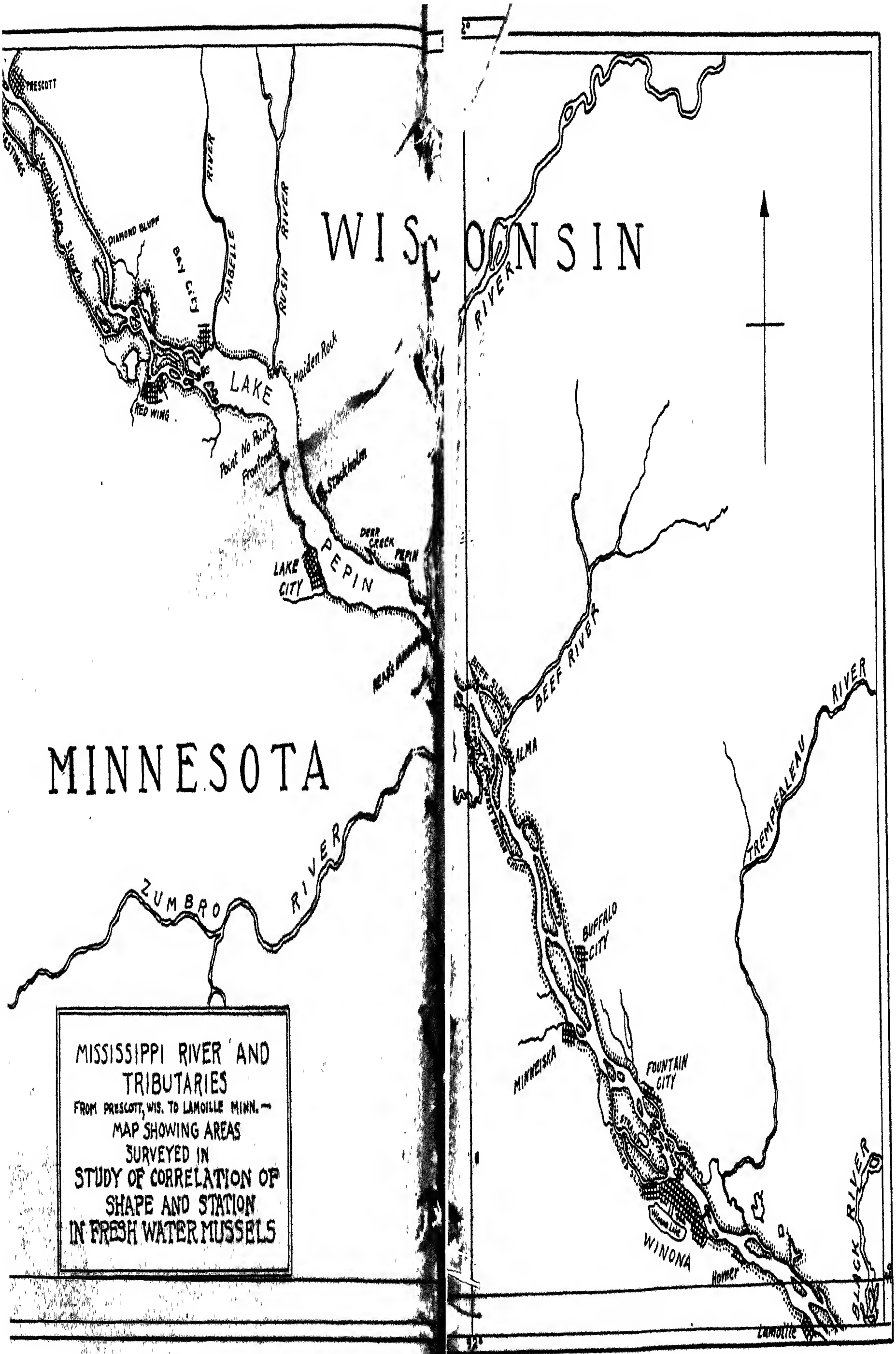
Locality	$\frac{DSD}{L}$				$\frac{DVD}{L}$			L		
	No.	Max.	Min.	Mean	Max.	Min.	Mean	Max.	Min.	Mean
Above Lake Pepin....	..	..	..	..	..	..	..	..	..	..
Lake Pepin..........	14	.76	.42	.59	.80	.50	.70	5.09	3.3	4.2
Below Lake Pepin....	14	.67	.26	.57	.84	.64	.78	7.8	3.8	4.9
Sloughs.............	3	.65	.60	.63	.84	.83	.82	5.4	4.8	5.2

TRUNCILLA TRUNCATA (Raf.). Sugar spoon

Locality	$\frac{DSD}{L}$				$\frac{DVD}{L}$			L		
	No.	Max.	Min.	Mean	Max.	Min.	Mean	Max.	Min.	Mean
Above Lake Pepin....	..	..	..	..	..	..	..	..	..	..
Lake Pepin..........	13	.60	.44	.58	.83	.66	.74	4.9	3.7	4.5
Below Lake Pepin....	13	.67	.47	.56	.84	.67	.76	6.5	4.05	5.11
Sloughs.............	3	.61	.57	.60	.85	.77	.81	5.97	4.1	5.01

LEPTODEA FRAGILIS (Barnes). Paper shell

Locality	$\frac{DSD}{L}$				$\frac{DVD}{L}$			L		
	No.	Max.	Min.	Mean	Max.	Min.	Mean	Max.	Min.	Mean
Above Lake Pepin....	..	..	..	..	..	..	..	..	..	..
Lake Pepin..........	19	.39	.27	.31	.64	.47	.53	10.7	7.04	8.7
Below Lake Pepin....	19	.40	.23	.31	.62	.50	.54	12.8	5.5	8.47
Sloughs.............	19	.45	.26	.32	.63	.48	.54	12.8	7.04	9.32



PRESCOTT
DIAMOND BLUFF
Bay City
ISABELLE
RIVER
RUSH RIVER
Maiden Rock
LAKE
RED WING
Point No Point
Frontenac
Stockholm
DEER CREEK
PEPIN
LAKE CITY
PEPIN
WISCONSIN
RIVER
BEEF SLOUGH
BEEF RIVER
ALMA
MINNESOTA
ZUMBRO
RIVER
TREMPEALEAU
RIVER
BUFFALO CITY
MINNEISKA
FOUNTAIN CITY
WINONA
Homer
BLACK RIVER
Lamoille
MISSISSIPPI RIVER AND TRIBUTARIES
FROM PRESCOTT, WIS. TO LAMOILLE MINN.—
MAP SHOWING AREAS
SURVEYED IN
STUDY OF CORRELATION OF
SHAPE AND STATION
IN FRESH WATER MUSSELS

PROPTERA ALATA (Say). Pink heel splitter

Locality	DSD/L				DVD/L			L		
	No.	Max.	Min.	Mean	Max.	Min.	Mean	Max.	Min.	Mean
Above Lake Pepin	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .
Lake Pepin	50	.37	.23	.30	.65	.43	.56	13.5	8.6	12.5
Below Lake Pepin	17	.39	.25	.30	.68	.54	.59	15.11	7.3	12.5
Sloughs	12	.38	.26	.30	.64	.52	.58	12.32	6.4	10.12

OBOVARIA OLIVARIA (Raf.). Hickory Nut

Locality	DSD/L				DVD/L			L		
	No.	Max.	Min.	Mean	Max.	Min.	Mean	Max.	Min.	Mean
Above Lake Pepin	50	.79	.40	.67	.90	.64	.73	7.7	5.4	6.9
Lake Pepin	2	.62	.51	.56	.75	.70	.73	5.2	5.1	5.1
Below Lake Pepin	50	.67	.54	.60	.79	.51	.71	8.6	3.1	5.6
Sloughs	34	.63	.53	.59	.94	.66	.73	8.4	3.1	5.9

LIGUMIA RECTA LATISSIMA (Raf.). Long John

Locality	DSD/L				DVD/L			L		
	No.	Max.	Min.	Mean	Max.	Min.	Mean	Max.	Min.	Mean
Above Lake Pepin	23	.37	.21	.28	.46	.36	.41	15.4	8.9	11.4
Lake Pepin	24	.38	.24	.30	.68	.20	.42	13.3	9.8	12.1
Below Lake Pepin	24	.37	.24	.29	.45	.39	.41	15.1	9.1	12.3
Sloughs	8	.31	.26	.29	.42	.38	.40	13.6	6.6	10.6

LAMPSILIS ANODONTOIDES FALLACIOSA (Smith). Yellow Sand Shell

Locality	DSD/L				DVD/L			L		
	No.	Max.	Min.	Mean	Max.	Min.	Mean	Max.	Min.	Mean
Above Lake Pepin	7	.41	.33	.35	.56	.47	.48	14.0	11.8	13.2
Lake Pepin	11	.43	.31	.36	.47	.36	.44	9.6	8.05	8.83
Below Lake Pepin	13	.41	.34	.38	.51	.46	.49	13.5	7.7	10.8
Sloughs	3	.50	.34	.39	.49	.43	.47	13.4	7.3	11.34

LAMPSILIS SILIQUOIDEA (Barnes). Lake Pepin Mucket

Locality	DSD/L				DVD/L			L		
	No.	Max.	Min.	Mean	Max.	Min.	Mean	Max.	Min.	Mean
Above Lake Pepin	50	.54	.31	.41	.66	.50	.56	11.9	6.8	9.7
Lake Pepin	50	.64	.32	.46	.76	.53	.62	9.7	6.2	8.1
Below Lake Pepin	33	.56	.39	.46	.65	.49	.56	12.1	5.5	8.7
Sloughs	50	.54	.31	.43	.79	.48	.54	12.1	4.5	8.7

LAMPSILIS OVATA VENTRICOSA (Barnes). Pocketbook

Locality	DSD/L				DVD/L			L		
	No.	Max.	Min.	Mean	Max.	Min.	Mean	Max.	Min.	Mean
Above Lake Pepin	50	.70	.45	.53	.96	.64	.70	12.8	9.4	10.5
Lake Pepin	50	.72	.47	.55	.83	.62	.72	12.4	5.7	9.0
Below Lake Pepin	50	.73	.49	.53	.91	.63	.72	11.5	6.8	9.7
Sloughs	50	.68	.42	.54	.91	.60	.69	13.9	7.6	10.6

The *Unioninæ* are regarded as the most primitive of these sub-families, and the only member of it represented in our material which we found to conform to the general law of becoming more convex in outline, passing downstream (upper river compared with lower river) is *Amblema*. This confirms Wilson and Clark's observation.[19] Possibly by way of compensatory growth it is longer in the upstream stretches, but on the other hand it is proportionately higher in the lower parts of the stream.

Species of *Unioninæ* which do not conform are *Fusconaia flava undata*, *Elliptio*, *Fusconaia ebenus*, and *Quadrula verrucosa*. Ortmann's observation for *Elliptio* is thus confirmed. The first two of these species are longer upstream and have a less proportionate height there; the latter two are shorter upstream, while only *Quadrula* has less height there. *Fusconaia* is the most primitive of these species.

The exception we note for *Fusconaia* is not at all in harmony with the observations on other members of this primitive genus. Ortmann[14] reports no less than six species groups belonging to this genus including this species that respond to the law as stated. Differences in the amount of material studied may explain the results in *ebenus* but hardly in *flava undata*. Perhaps in the latter a high compressed race of shells has developed in response to the conditions of the Mississippi below Lake Pepin.* There seems little probability of a confusion of identity in the material studied. However, as will be seen later, this species responds to the river lake environment in an expected and typical manner.

Among the *Anodontinæ* we see that *Lasmigona complanata* conforms to the law and this appears to be the first case noted as occurring in this sub-family. The longest shells were found in the upper river, but there is also a compensatory increase in height going downstream. *Strophitus* does not become inflated in the lower river, confirming Ortmann's earlier observation, but shows, however, a shortening of the shell and a decrease in height.

The sub-family *Lampsilinæ* has many characters intermediate between those of the *Anodontinæ* and the *Unioninæ*, and includes the most advanced types of the Naiades, as shown in part by the expression of sexual differentiation in the shell. The genus *Lampsilis* is among those most highly differentiated. Members of this sub-family which follow the law are *L. siliquoidea*, *Ligumia* and *L. anodontoides*. Ortmann could not detect any such response in his material for the first two species named. A possible explanation for this variance from Ortmann's results in *L. siliquoidea* is that the shells may have been carried downstream from Lake Pepin, where the environment is known to be exceptionally favorable for this species of shell,† where it is being continually propagated by the

* Ortmann studied typical *flava* (Raf.) and *F. flava trigona* (Lea). The relation of these forms to var. *undata* Barnes is open to further investigation, although Utterback (loc. cit.) considers that *undata* passes into *trigona*.

† *L. siliquoidea*, in the upper Ohio drainage, distinctly prefers quiet reaches of the streams. Ortmann further states in correspondence that this divergence from his results may be explained by the fact that he had hardly any material from a river as *large* as the Mississippi.

Bureau of Fisheries, and where, as will be seen, the shells are generally more inflated than in the lower river. It is possible also that the same factors may affect our results from other species to some extent. No change in proportionate height in the lower river is noted for either of these two species, but *L. siliquoidea*, *L. anodontoides* become shorter and *Ligumia* longer in the lower stretches of the river. *L. anodontoides* becomes higher in the lower stretches of the river, but no such change is noted for *L. siliquoidea* or *Ligumia*.

The species of this sub-family which do not conform are *Lampsilis ventricosa*,* which averages the same degree of inflation in both the upper and lower river, and *Obovaria olivaria*. The latter is also a primitive genus within the *Lampsilinæ*, but the related species, *subrotunda* Raf., is known very definitely to become inflated in the lower stretches of streams. We had no material from the upper river for the remaining species of *Lampsilinæ* listed, but our results in the case of *Obliquaria reflexa*, another primitive form, confirm Danglade's observation[4] that it does not become inflated in the lower stretches of streams, but instead is longer and higher. These conclusions are essentially those reached by Ball,[2] viz., that shells of the same species often change in shape according to the size of the stream in which they occur; that shells of a smaller stream are less swollen than those of larger streams; that certain groups show this correlation much more strongly than others, and that in some cases there is apparently no relation between the size of stream and the degree of obesity. To these may be added the statement that changes in one dimension of a shell are usually accompanied by compensatory changes in other dimensions, possibly to be correlated with the environment.

The (River) Lake Environment and the Upper and Lower River Environments

Most of the shells from Lake Pepin have the regular growth lines and polished epidermis characterizing lake shells, and possibly less disturbed water, but none of the shells we collected there were depauperate in appearance, although certain species appear to avoid the lake. The tables permit us to observe other effects of the river lake environment in the following species, which attain at least a slightly greater obesity in Lake Pepin than either the upper or lower river, viz., *Ligumia*, *Amblema*, *Lasmigona*, *Lampsilis ventricosa*, and *Strophitus edentulus*. Of these, *Amblema* and *Lasmigona* were observed to be more inflated in the lower river than the upper river. *Lampsilis ventricosa* and *Strophitus* attain a higher degree of inflation in Lake Pepin than in either the upper or lower river. *Lampsilis siliquoidea* averages the same in both lake and lower river, possibly for reasons already given. Correlated also with the river lake environment is a greater proportionate height in *Lampsilis siliquoidea*, *Strophitus*, *Ligumia* and possibly *Lampsilis ventricosa*, while *L. complanata* has a greater proportionate height in the lower river

* Ortmann writes to one of us under date of Feb. 5, 1926, that *L. ventricosa* of the Mississippi, lower Ohio and Illinois River is a peculiar swollen race, not exactly identical with the *ventricosa* of the head waters of the Ohio.

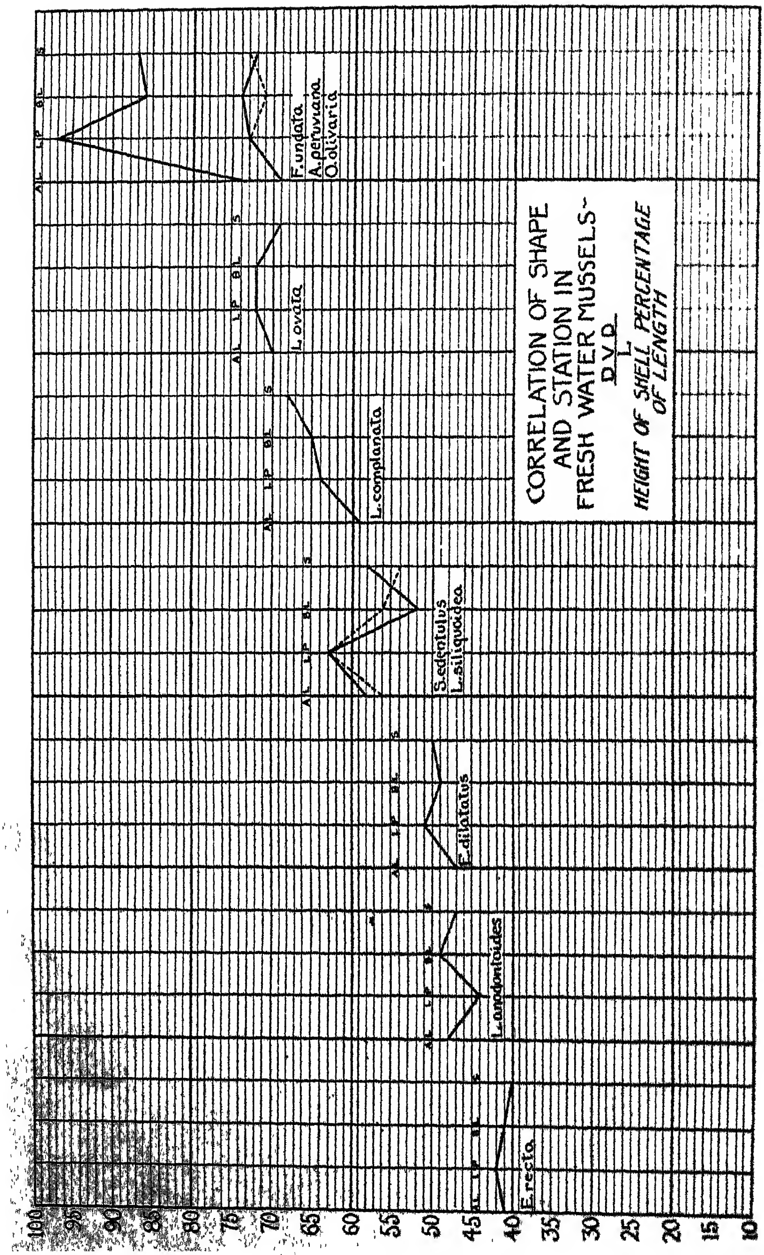
only. This characteristic of the latter shell may be a direct response to the swifter current and sand and mud bars on which it is found burrowing there. In this connection, its common name of "hell splitter" becomes significant. Common in the same habitats are *Fusconaia flava undata*, *Leptodea*, *Amblema* and *Proptera alata* which in these circumstances all attain a greater proportionate height. The external resemblance between *Lasmigona* and *Proptera* is unusually close, and they may be distinguished superficially only by their beak sculptures, hinge and color of nacre. Generally speaking, they also parallel one another in their habitats. Shall we say that their shell architecture is an effect of their common environment?

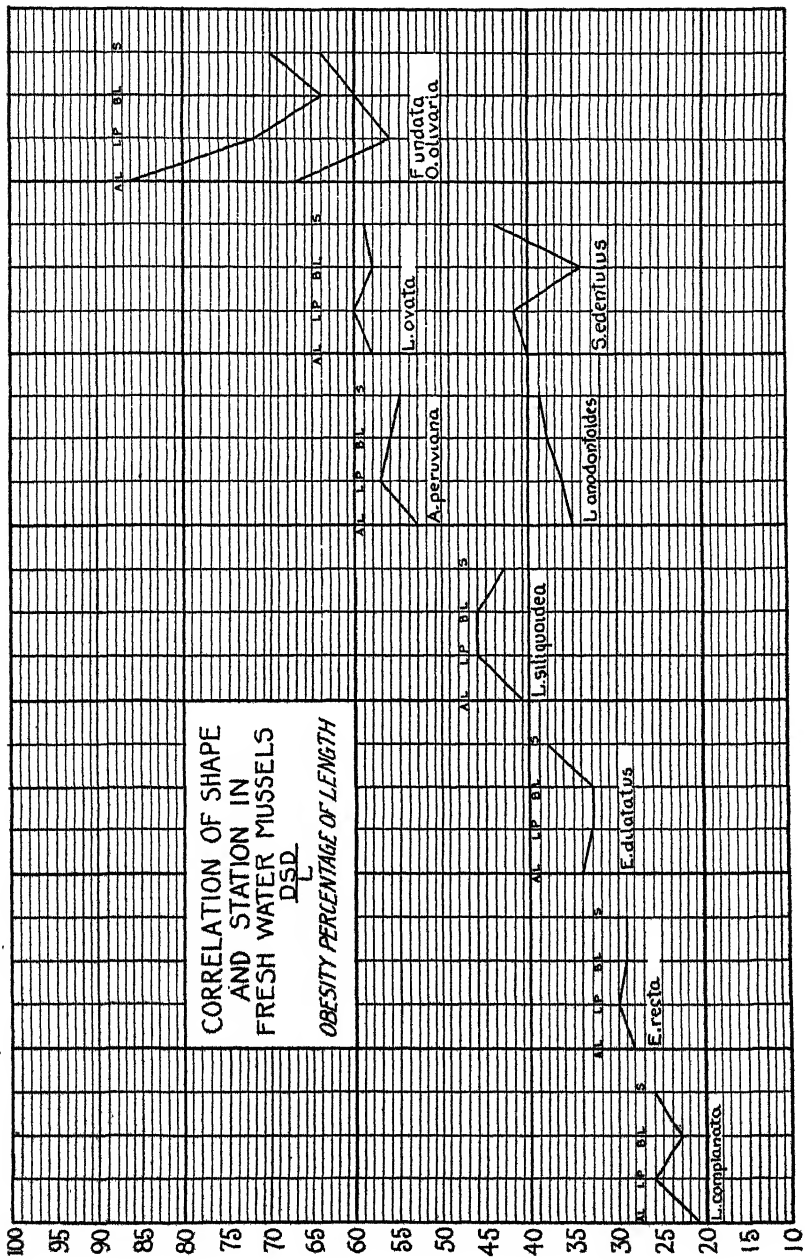
While *Elliptio* and *Fusconaia flava undata* attain their greatest inflation elsewhere, it was noted that specimens of these shells collected from the (river) lake, Lake Pepin, agree in general resemblance and dimensions to the variety *sterkii* of the former and the variety *F. flava parvula* related to the latter, described by Grier from Lake Erie.[7] The degree of inflation of *F. flava undata* is greater in Lake Pepin shells than in the Lake Erie variety mentioned, although it is less than those from upstream. Baker records var. *sterkii* from Lake Winnebago.[1] Further comparison of all applicable dimensions given by Ortmann of shells from Lake Erie[12] with the maxima, minima, and mean of the shells we collected from Lake Pepin indicate the close similarity in morphological characters of the following species in Lake Pepin, with the corresponding species or variety in Lake Erie, viz., *Amblema peruviana* (*Amblema plicata* Say); *Leptodea fragilis* (*Paraptera fragilis* Raf); *Proptera alata* Say, *Ligumia recta latissima* Raf. (*Eurynia recta* Lam.); *Lampsilis siliquoidea*, Barnes (*Lampsilis luteola rosacea* DeKay); *Lampsilis ovata ventricosa* Barnes (*Lampsilis ovata canadensis* Lea). This fact offers some confirmation of the statement of Baker,[1] earlier cited in this paper, to the effect that the morphological characters of shells which have migrated from a river to a lake are highly predictable ones.

Lasmigona, *Strophitus*, *L. ventricosa* and *L. siliquoidea* are shorter in Lake Pepin than the other environments. *Ligumia*, however, is longer in Lake Pepin than in the upper river, but approximately the same in the lower river. *Amblema* is longer in Lake Pepin than in the lower river, but shorter there than in the upper.

The River Lake Environment and the Sloughs

Most of the shells from the sloughs had the same general appearance as those collected in Lake Pepin. Comparing these shells with those from the upper and lower river alone, a greater obesity is noted in the slough forms of *Plethobasus*, *L. ventricosa*, *Lampsilis anodontoides*, *Lasmigona*, *Fusconaia flava undata* (as compared with lower river), *Elliptio* and *Strophitus*. Correlated with the environment is a greater height in *Lasmigona*, *Elliptio* and *Fusconaia*. There is no change in the proportion in our material for *Plethobasus*, while *L. ventricosa* apparently attains a greater height in both upper and lower rivers and Lake Pepin than in the sloughs. *L. anodontoides* is higher in both upper and lower rivers than in the sloughs. *Strophitus* is higher in Lake Pepin and possibly the upper river, but lower in


CORRELATION OF SHAPE
AND STATION IN
FRESH WATER MUSSELS-
D V D
L
HEIGHT OF SHELL PERCENTAGE
OF LENGTH
F. undata
A. peruviana
O. olivaria
L. ovata
L. complanata
S. edentulus
L. siliquoidea
E. dilatatus
L. anodontoides
E. recta
AL LP BL S
100
95
90
85
80
75
70
65
60
55
50
45
40
35
30
25
20
15
10


CORRELATION OF SHAPE
AND STATION IN
FRESH WATER MUSSELS
DSD
L
OBESITY PERCENTAGE OF LENGTH
100
95
90
85
80
75
70
65
60
55
50
45
40
35
30
25
20
15
10
AL LP BL S
L.complanata
E.recta
E.dilatatus
L.siliquoidea
A.peruviana
L.anodontoides
L.ovata
S.edentulus
F.undata
O.olivaria

the lower river than in the sloughs. *L. ventricosa* and *Lasmigona* attain their greatest length in the sloughs; *L. anodontoides*, *F. flava* and *Elliptio*, a greater length than in any other place except the upper river. *Strophitus* is shorter in the sloughs than in any other habitat except Lake Pepin.

Of the species attaining their greatest inflation in the sloughs as compared with the upper or lower river, the following are also more inflated in Lake Pepin than either the upper or lower river; viz., *Lasmigona*, *L. ventricosa* and *Strophitus*. These three species are shorter here than elsewhere, and their other correlations have been previously dealt with. The behavior of these three shells may possibly indicate some parallelism of effect on these species of the more greatly similar lake environment. No appreciable effect is noted for *Anodonta* in either the slough or lake environment beyond the fact that it is higher in Lake Pepin, where it also possibly attains a maximum inflation. However, other observers have previously commented on the greater size it attains in lakes and sloughs although longer specimens were found outside of them.

If we compare the sloughs with all other types of environments, we find that *Lasmigona* and *Elliptio* attain a higher degree of inflation there than anywhere else. Such a statement can hardly be made for *Leptodea* and *Plethobasus* on account of the scarcity of proper material. Correlated with this habitat is a greater proportionate height in *Lasmigona* and possibly *Elliptio*. *Lasmigona* undoubtedly attains its greatest height here, while *Elliptio* is higher in the sloughs than in the upper or lower river. *Obliquaria* is more inflated in the sloughs than elsewhere for the material we had, and is also higher and longer there. The most satisfactory results from the slough shells would, of course, have been obtained from mussels which had unquestionably passed their entire life there.

Conclusions

1. Under the conditions of this study and within the limits of the material used, three species of Naiades in addition to those previously known show evidence of becoming more convex in the lower stretches of streams. They are *Lasmigona complanata*, *Ligumia recta*, *Lampsilis anodontoides*, and possibly *Lampsilis siliquoidea*. Correlated with the increase in degree of inflation is the fact that three of these species (*Lasmigona*, *L. anodontoides* and *L. siliquoidea*) become shorter, while two (*Lasmigona* and *L. anodontoides*) proportionately higher.

2. The effect of the interpolated (river) lake environment between the upper and lower rivers is to increase the convexity of certain species, viz., *Ligumia*, *Lasmigona*, *Amblema*, *Lampsilis ventricosa*, and *Strophitus edentulus*. While some of these are also shown to become more inflated in the lower stretches of the river, yet their convexity is greatest in the (river) lake environment. Correlated with the latter is a greater proportionate height in three of these species, *L. siliquoidea*, *Strophitus* and *Ligumia*, and a diminution in the length of four of them—*Lasmigona*, *Strophitus*, *L. ventricosa* and *L. siliquoidea*. The foregoing indicate some of the

differences between the river and the river lake forms of the same species of mussel.

3. The tendency of the slough environment is to parallel that of the lake in inflating the shells of certain species. In some species this is accompanied by a proportionately greater height, as in *Lasmigona*, *Elliptio* and *Fusconaia flava undata;* in others by less height, as in *Lampsilis ventricosa* and *anodontoides;* in still others by a greater length, as in *L. anodontoides*, *F. flava undata*, *Elliptio*, *L. ventricosa* and *Lasmigona;* and by less length in *Strophitus*.

Little can be said to account for the facts brought out. It is conceivable that some of the changes in shell architecture shown to take place are advantageous to the mussels; for instance, the flatter and larger forms of shells found in the upper river might enable the animal to orientate itself to the current much more easily than a swollen form, such as that found in Lake Pepin. Ball[2] observed in most of the species studied by him that young shells were more swollen than older ones. Perhaps a partial explanation to some of the more inflated shells of some species downstream or in Lake Pepin lies in the possibility the more highly inflated young shells being carried there by the current and dropped; but according to inferences to be taken from a recent paper by Ortmann,[14] such a process does not explain the presence of the inflated varieties of shells in Lake Erie. Much of course may depend on the habits of the species. But Ortmann[16] gives us an interesting clue in his observation on *Fusconaia cuneolos* Lea which "possibly indicates that not so much the size of the stream, as the character of bottom and current, determines the development of the big-river-type." To the authors the statement of Haas and Schwarz[8] has peculiar pertinence in connection with the results of the investigation.

"The same types under the same biological (ecological) conditions produce the same variants; different types under like conditions produce convergent (parallel), local variants. In the case of sufficiently lengthy isolation the local variants subject to biologically similar conditions may become constant or fixed local forms." (Free translation.)

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BULLETIN

of the

WAGNER FREE INSTITUTE OF SCIENCE OF PHILADELPHIA

PUBLISHED BY THE INSTITUTE

Editor

HENRY LEFFMANN, A.M., M.D., PH.D.

Associates in Editorship

SAMUEL T. WAGNER, B.S., C.E., President of the Institute

CARL BOYER, Curator

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No. 4	September, 1926	Single numbers, 20 cents

ANNOUNCEMENTS

THE regular courses of instruction at the Institute are arranged in a fall and a spring series. In addition to the lectures in the auditorium, instruction is given in the Museum, utilizing its large and comprehensive collections. This combined instruction is articulated with work at Temple University and the Division of Science Teaching in the Board of Public Education, so that those teaching General Science in eighth and ninth grades of the Philadelphia Public Schools, or preparing for such teaching, may secure elective credits upon the completion of work as follows:

General Science II

Monday,	7 P. M. to 8 P. M.	Museum Lecture.
	8 P. M. to 9 P. M.	Lecture Course—Botany and Zoology.

NOTE: Four semester hours of credit will be given for the complete Monday evening program.

Tuesday,	8 P. M. to 9 P. M.	Lecture Course—Inorganic Chemistry and Geology.
Wednesday,	8 P. M. to 9 P. M.	Lecture Course—Organic Chemistry and Physics.

NOTE: An additional two semester hours of credit per evening may be obtained by electing Tuesday or Wednesday evening.

Monday evening is a prerequisite for these, however.

Further information concerning these courses may be obtained at the Office of the Institute.

FACULTY CHANGES

Professor S. T. Wagner (Engineering), Professor S. Trotter (Zoology), Professor C. H. LaWall (Organic Chemistry), have resigned. The following appointments have been made to fill the vacancies: Professor John Wagner, Jr. (Engineering), Professor Ivor Griffith (Organic Chemistry). Professor S. C. Schmucker has been transferred to the chair of Zoology, relinquishing that of Botany. Mr. G. B. Kaiser has been appointed Lecturer on Botany. Professor Schmucker has been elected President of the Faculty, and Professor Griffith, Secretary.

MUSEUM NOTES

Recently a considerable number of plants from the Alpine district of New Zealand (South Island) have been added by exchange through the courtesy of Mr. F. B. Blackwell of Auckland and Mr. R. M. Laing of Christchurch. Many of the specimens have been determined by Cheeseman, the author of the standard "Flora of New Zealand," and a few by L. Cockayne, a botanist of prominence. Some of the specimens are from altitudes of over 4,000 feet, growing above the timber line. The Institute herbarium now has a well-selected and illustrative collection from the antipodes. Through the courtesy of Mr. J. W. Powell of Mesilla Park, New Mexico, a specimen of the Syrian bean-caper, *Zygophyllum fabago*, has been added. This plant has appeared lately in the neighborhood of Mesilla Park, and has established itself there, being much frequented by bees. Specimens of it have been occasionally found on ballast grounds in the eastern United States, but the development in New Mexico seems to be the first colonization.

To increase the usefulness of the Museum, a series of electric lights has been installed which will enable the collections to be examined at all convenient hours.

RESEARCH LABORATORY NOTES

Studies of pollen and of conditions of crystallization are in progress. Especial attention has been given to the photography of pollen grains, and some results of the work are reported elsewhere in this BULLETIN. Further investigations on post-fixation development, a study of which was presented in Volume 10 of the Transactions, are also in progress.

STUDIES IN POLLEN

By Henry Leffmann and Max Trumper

(Contribution from the Research Laboratory of the Wagner Free Institute of Science)

Pollen has been the subject of much study, several books having been written about it and many illustrations made. In early days, direct drawing with the camera lucida was used, but photography offers more satisfactory results. We have lately given considerable attention to this method and have found that ordinary plates with a blue screen give good pictures. Panchromatic plates with red screen are also satisfactory for such work and for some other procedures in photomicrography, but are troublesome in development on account of their extreme sensitiveness, although this difficulty may be avoided in great part by using the desensitizing solutions discovered by Lüppo-Cramer.

It would seem that pollen forms might be useful as additional data in morphology, thus aiding in determining affiliations, but this hope does not seem to be borne out by experience. One of the most recent contributions to the comparison of pollen forms is by Miss Maxy Alice Pope, Assistant Curator of the Colorado State Museum. That Museum, in association with a special committee appointed by the State Historical and Natural History Society of Colorado, has been making extensive studies on pollens that cause hay fever. Dr. James J. Waring was in general charge of the investigations, and Miss Pope undertook the systematic collection and examination of the pollens. Miss Pope has also contributed papers to the *Botanical Gazette* giving numerous drawings made with the camera lucida.

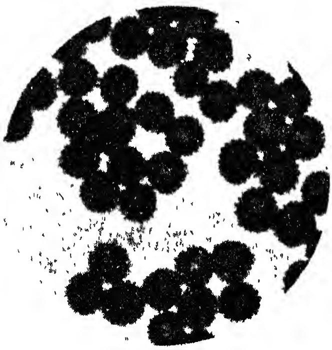
Apart from the interest in pollen forms as morphologic data, much present-day investigation is with reference to the causation of hay fever. A popular notion that the irritation is due to spiculation of the grains is unfounded. Hay fever is caused by the reaction of the individual to some constituent of the grains, probably a protein. Whether or not a given pollen will cause the disease depends merely upon whether it is blown about. It is the dusty, wind-borne forms that infect. This has been well shown in a recent experience reported by Professor George Potts of Bloemfontein, South Africa. In that region the so-called "pepper-tree" (*Schinus molle* L.) is extensively cultivated for ornament. It is not a pepper-tree, but belongs with the sumacs. Ordinarily the pollen is sticky and insect-borne, but the climate in Bloemfontein is very dry and windy, and Potts found that a great deal of the pollen is blown about. He found the grains in the catarrhal discharges from patients. It has been recently reported that in some parts of California in which the tree grows the dryness of the climate also has caused some wind distribution of the pollen, with resulting infections.

Pollens differ greatly in size and form when wide ranges of plants are examined. The mallows, such as Althea and Hollyhock, have very large grains highly spiculated. Indian Corn has also large grains but they are not spiculated. Sometimes they have a curious resemblance to the corn grain. Ragweed pollen is com-

paratively small and highly spiculated. It is spherical. The ox-eye daisy has ovoid, spiculated pollen. The most remarkable form common in the eastern United States is that of the roadside weed, evening primrose (*Oenothera biennis* L.), the grains being large and triangular, connected by glutinous filaments. Miss Pope has found similar forms in other species of the family (*Onagraceæ*) to which the evening primrose belongs.

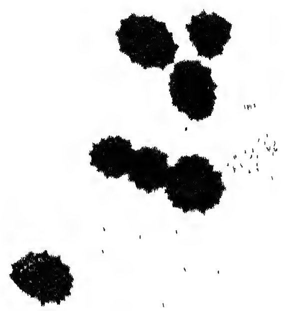
The difficulty of photographing pollen arises principally from its being usually pale yellow, which contrasts but feebly with the general field of the microscope. Efforts at staining have not been

Causing hay fever

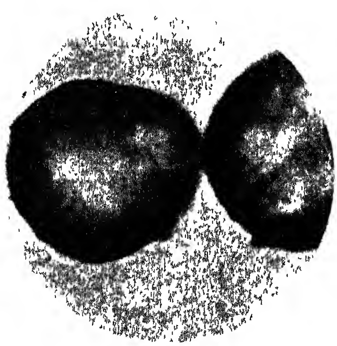


RAGWEED
Ambrosia trifida L.

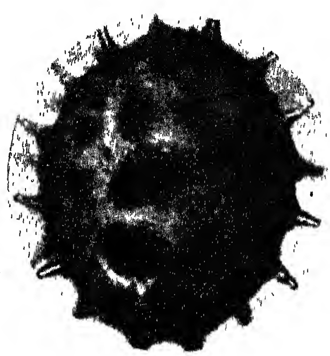
Not causing hay fever



OX-EYE DAISY
Chrysanthemum leucanthemum L.



INDIAN CORN
Zea mays L.



SHRUBBY ALTHEA
Hibiscus syriacus L.

All of same magnification—about 300 diameters. Photomicrographs in research laboratory of the Institute. 1926.

successful. Stains dissolved in alcohol or water are liable to alter the form, while those dissolved in oil (as the sudan stains) or in benzene do not penetrate the outer layer. It has been found best to spread the pollen dry on the slide and use the blue screen. In some cases a considerable amount of the grains has been obtained by immersing the flower in a few centimeters of pure benzene and

allowing the grains to settle. A small portion of the deposit is taken up with a glass tube of small bore and dropped on the slide. In a few moments the benzene evaporates and the specimen may be examined. Some waxy, glutinous matter that causes the grains to adhere in lumps is dissolved out by this method and the grains are largely isolated. The time during which the solvent acts is not sufficient to alter the grains.

For a given species the pollen is fairly regular in form and size, but, as with all living organisms, abnormalities are occasionally noted. In some cases the grains may be immature. As illustrating the fact that neither the form nor the size of the grains determines the production of hay fever, copies of photographs recently made in the research laboratory of the Institute are appended.

LECTURES IN FALL COURSE, 1926

(Schedules of lectures of the Spring Course of 1927 will appear in next issue of the BULLETIN.)

CIVIL ENGINEERING 3

PROFESSOR WAGNER

Water Supply—Sewers—Canals—Rivers and Harbors

Lectures begin at 8 P. M.

1. Friday, September 10.
   Hydrography. Water surveys of all kinds. Soundings. Discharge of streams. Current meters.
2. Friday, September 17.
   Water Supply. Water and its impurities. Analysis—chemical and biologic. Interpretation of analyses.
3. Friday, September 24.
   Water Supply (Continued). Sources of water. Consumption. Meters. Storage reservoirs.
4. Friday, October 1.
   Water Supply (Continued). Construction of reservoirs and dams of earth and masonry. Distributing systems. Aqueducts. Pipes.
5. Friday, October 8.
   Water Supply (Continued). Purification. Distilling. Boiling. Disinfection. Sedimentation. Filtration. Softening. Straining.
6. Friday, October 15.
   Water Supply (Continued). Rapid and slow sand filters—their design and construction.
7. Friday, October 22.
   Water Supply (Concluded). Roughing filters. Description of filter plants. Cost. Reduction of typhoid by filtration.
8. Friday, October 29.
   Sewers. Definitions. Sewerage systems. Requirements of a good system.
9. Friday, November 5.
   Sewers (Continued). Location. Determination of amount of sewage and storm water. Formulæ.
10. Friday, November 12.
    Sewers (Continued). Size. Construction. Excavation and refilling.
11. Friday, November 19.
    Sewers (Continued). Materials of construction. Details of construction. Maintenance.
12. Friday, November 26.
    Sewers (Concluded). Disposition. Processes for purification. Disposal of sludge.
13. Friday, December 3.
    Canals. Classification. History. Cross-section. Water supply. Reservoirs. Feeders.

14. Friday, December 10
Canals (Concluded). Levels. Locks. Locomotion. Ship canals. Notable canals.
15. Friday, December 17.
Rivers. Natural features. Protection of banks. Bars. Inundations. Regulation. Slack water navigation.
16. Thursday, December 23.
Harbors. Roadsteads. Harbors, Natural, Artificial. Dikes. Sea walls. Breakwaters.

BOTANY 4

MR. KAISER

Physiology and Ecology

Lectures begin at 8 P. M.

1. Monday, September 13.
Metabolism. Nutrition. Conditions of plant growth. Constituents of plants. Elements necessary. How obtained.
2. Monday, September 20.
Photosynthesis. Formation of carbohydrates and chlorophyl. Enzyms (diastase). Chemisynthesis.
3. Monday, September 27.
Assimilation of nitrogen. Carnivorous, parasitic, and symbiotic plants. Nitro-bacteria.
4. Monday, October 4.
Respiration. Comparison with photosynthesis. Phosphorescence. Fermentation, growth and development. Duration of plant life.
5. Monday, October 11.
Movement in plants. Phototaxis. External stimuli. Sleep of plants.
6. Monday, October 18.
Reproduction. Vegetative and gamic. Pollination by different methods. Fruit and its dissemination.
7. Monday, October 25.
Ecology. Plant distribution in relation to environment. Succession of plants in geologic time.
8. Monday, November 1.
North Temperate zone. North America. Coastal plain. Gulf states. Prairies, mountains, great basin. Pacific coast. Forest, grassland and desert.
9. Monday, November 8.
North Temperate zone (Continued). Europe. British Isles. North Africa, Asia and Japan, Mediterranean and Himalayan floras, Russian steppes, Atlantic Islands.
10. Monday, November 15.
Tropics of both hemispheres. Africa, continental Asia. Malaya, Polynesia, Central America, South America, West Indies. Tropical forests.
11. Monday, November 22.
South Temperate zone. South Africa, Australia, New Zealand. Fuegia and Chile, Cape Region. Peculiar floras of Australia and parts of South America.
12. Monday, November 29.
Plants in relation to man. Man's influence on evolution. Plant breeding. Natural and methodical selection, variation, mutation, heredity, hybridization, weeds. Recapitulation.

INORGANIC CHEMISTRY 2

PROFESSOR HORN

Descriptive Chemistry

Lectures begin at 8 P. M.

1. Tuesday, September 14.
Chlorine. Occurrence, preparation, properties, industrial uses. Isotopy.
2. Tuesday, September 21.
Chlorine compounds. Polyvalence of chlorine. Hydrochloric acid, hypochlorites, chlorates, perchlorates.
3. Tuesday, September 28.
Bromine, Iodine, Fluorine. General chemistry of the halogens; hydrogen halides and halogen oxides. Chemical equilibrium. Modern atomic weight determinations. Halogen halides.

4. Tuesday, October 5.
   Sulphur. Occurrence, properties. Sulphides. Sulphur and the Phase rule. Molecular weight of sulphur. Sulphur chlorides.

(No lecture Tuesday, October 12.)

5. Tuesday, October 19.
   Sulphur (Continued). Oxides; properties and uses. The principal sulphur acids. Commercial catalysis. Desmotropism. Sulphuric acid. Caro's acid.
6. Tuesday, October 26.
   Selenium, Molybdenum and Vanadium. Actinic phenomena. Composition of polyacids as exceptions to "Definite Proportions." Elements discovered through difficulties in mineral analysis. Vanadium in steels.
7. Tuesday, November 2.
   Nitrogen. Occurrence, properties. Fixation of atmospheric nitrogen. The noble gases. Hydrides of nitrogen. The atmosphere.
8. Tuesday, November 9.
   Nitrogen (Continued). Oxides of nitrogen and hydroxides of nitrogen. Nitric, nitrous and hyponitrous acids.
9. Tuesday, November 16.
   Phosphorus. Sources, preparation, properties, allotropic forms. Hydrogen phosphide. Halides and sulphides of phosphorus. Matches.
10. Tuesday, November 23.
    Phosphorus (Continued). Agricultural and biologic importance of phosphates. Acid phosphates. Phosphoric and other acids of phosphorus.
11. Tuesday, November 30.
    Arsenic and Boron. Sources, preparation, properties, and uses. Physiological action. Oxides and sulphides, arsenites, borates, and perborates.
12. Tuesday, December 7.
    Scandium, Gallium, Germanium, Indium, Beryllium. Chemical systematics, and prophesies based thereon. Laws of isomorphism and specific heat.

ORGANIC CHEMISTRY 2

PROFESSOR GRIFFITH

Carbohydrates, Fats, Oils and Waxes

Lectures begin at 8 P. M.

1. Wednesday, September 15.
   Cellulose. Cotton, linen, hemp, ramie, esparto, coir. Derivation. Physical and chemical properties.
2. Wednesday, September 22.
   Manufactured Cellulose and Cellulose Derivatives. Paper, cardboard, wood substitutes, cellulose compositions, mercerized cotton, lacquers and paints, artificial silk, explosives.
3. Wednesday, September 29.
   Starch. Origin, distribution, varieties, chemical and microscopical characteristics. Starch in the dietary.
4. Wednesday, October 6.
   Starch Derivatives. Dextrin, glucose (from starch and cellulose), dextrose, manufacture, uses.
5. Wednesday, October 13.
   Natural Sugars and Their Derivatives. Sucrose (from cane, beet, and maple), lactose (from milk), mannite, invert sugar. Chemical tests for sugars.
6. Wednesday, October 20.
   Oils, Fats and Waxes. General properties, uses and classification. Occurrences, methods of separation, proximate principles, olein, palmitin, stearin.
7. Wednesday, October 27.
   Oils. Non-drying oils: Olive, cottonseed, almond, peanut, sesame, maize, castor, lard.
8. Wednesday, November 3.
   Oils. Drying oils: Linseed, soy, hemp, China wood, poppy, sunflower.
9. Wednesday, November 10.
   Fats: Animal and *vegetable.* Palm, cocoanut and chocolate fats, lard, tallow.
10. Wednesday, November 17.
    Waxes and Miscellaneous Fats. Beeswax (yellow and white), spermaceti, Carnauba wax, wool fat, rosin oil.
11. Wednesday, November 24.
    Milk Fat, Commercial Products and Imitations. Milk, cream, butter, cheese, oleomargarin, filled milk, evaporated milk, powdered milk.
12. Wednesday, December 1.
    Soaps. Composition and classification. Physical and chemical properties.

WAGNER FREE INSTITUTE OF SCIENCE

Montgomery Ave. and Seventeenth St., Philadelphia, Pa., U. S. A.

FACULTY

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William H. Dall, A.M., Sc.D.	Invertebrate Paleontology
Henry Leffmann, A.M., M.D., Ph.D.	Chemistry
William B. Scott, A.M., Ph.D., LL.D.	Geology
George F. Stradling, Ph.D.	Physics
Samuel T. Wagner, B.S., C.E.	Engineering

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Ivor Griffith, Ph.M., *Organic Chemistry*

Department of Geology and Physiography
Mayville W. Twitchell, Ph.D., *Geology*

George B. Kaiser, *Lecturer on Botany*

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ANNOUNCEMENTS

THE arrangements with Temple University and the Division of Science Teaching in the Board of Public Education announced in the September issue of the BULLETIN have been carried out with entire satisfaction since the opening of the Institute lecture courses on September 13. The attendance has been gratifying as to numbers and the interest shown by the students. The arrangements will continue during the remainder of the Institute's scholastic year. Details of the regular lecture courses are given in the present issue, and announcements of the museum lectures will be made from time to time as usual. For the information of prospective students some data are here repeated from the September BULLETIN, including only the courses that remain to be given.

Monday,	7 P. M. to 8 P. M.	Museum Lecture.
	8 P. M. to 9 P. M.	Lecture Course—Zoology.

NOTE: Four semester hours of credit will be given for the complete Monday evening program.

Tuesday,	8 P. M. to 9 P. M.	Lecture Course—Geology.
Wednesday,	8 P. M. to 9 P. M.	Lecture Course—Physics.

NOTE: An additional two semester hours of credit per evening may be obtained by electing Tuesday or Wednesday evening, but Monday evening is a prerequisite for these.

Further information concerning these courses may be obtained at the Office of the Institute.

Entered as second-class matter, September 10, 1926, at the Post Office, Philadelphia, Pa., under Act of August 24, 1912.

RICHARD B. WESTBROOK FREE LECTURESHIP 1927

This course will consist of four lectures given on the evenings of Friday, March 4, Saturday, March 5, Friday, March 11, and Saturday, March 12. The subject will be:

AN INTERPRETATION OF ATLANTIC COAST SCENERY

BY DOUGLAS W. JOHNSON, PH.D.
Professor of Physiography, Columbia University

A detailed syllabus of the lectures will appear in the BULLETIN for February, 1927. The following is an outline of the course:

1. Waves and their Work.
2. The Evolution of Shore Lines.
3. Is the Atlantic Coast sinking? Affirmative view.
4. Is the Atlantic Coast sinking? Negative view.

The lectures will begin at 8 P. M., and will be fully illustrated.

MUSEUM AND LABORATORY NOTES

The electric lighting for the Museum has been completely installed and the whole collections of the Institute are now available at all suitable hours. Additions have been made to the botanical collection, especially numerous samples of fungi from this district collected and determined by Mr. Boyer. Further studies of pollen have been made in the laboratory.

The grounds of the Institute are being thoroughly improved under the supervision of a firm of landscape gardeners. As much of the work as can be done in the fall has been completed and the remainder will be done in the spring.

A STUDY OF THE VIRGINIA OPOSSUM

(*Didelphis virginiana* Kerr: FAMILY *Didelphyidæ*)

BY W. HENRY SHEAK

The opossums are a striking example of discontinuous distribution. With the exception of this family, there is no marsupial found outside the Australian region. The opossums at the present day are confined mostly to the tropical and subtropical parts of America, but the subject of this sketch, the Virginia opossum, is pushing its way farther and farther into the north temperate zone. The question naturally arises, How did this single family reach a point so distant from the Australian home of the pouched mammals? And the further question, What led to the extinction of all members of the family, or ancestors of the family, who paused on the way to the New World?

Numerous fossils of marsupial mammals, principally lower jaws, have been found in Eocene and early Miocene formations of France. These were animals about the size of the common rat and very similar to the typical modern opossums. One or two similar species have been taken from the Eocene of southern England. Some remains have been found in the caves of Brazil, but these are closely allied to, or identical with, the species now living in the same region. So we know little of the immediate ancestors of this group.

Among modern marsupials, the opossums are most nearly related to the dasyures, and closely resemble them in many points of structure, but the dasyures differ in their fewer number of incisor teeth, their varying number of premolars and molars, and in having the hallux or great toe rudimentary or altogether wanting, and in the total absence of a cæcum or blind canal connected with the forward end of the intestinal tract.

The Didelphyidæ, or opossum family, embraces twenty-five or thirty species. They are characterized by having ten incisors in the upper jaw and eight in the lower, one canine tooth in each side of each jaw, three compressed premolars, and four sharply-tuberculated molars on each side, above and below—fifty teeth in all, the largest number in any heterodont mammal, excepting only the Australian ant-eater (*Myrmecobius fasciatus*) which has fifty-two teeth, and sometimes as many as fifty-four. The incisors in the opossums are very small and pointed, the canines large and prominent. There are five digits in both the hands and the feet. The hallux, or great toe, is expanded into a broad flat pad, is widely divergent from the other toes, and fully opposable to them, as in most of the monkey tribe, but is without a nail or claw. The first digit of the hand is a thumb, but it is not as completely opposable as the great toe. All the digits, except the hallux, are armed with long curved, sharp claws. The feet are plantigrade, having the entire sole resting on the ground, as in bears and human beings. The cæcum is of small or moderate size, but always present.

In some species the pouch is incomplete or even wanting, but in the Virginia opossum it is as perfect as in any of the kangaroos. The tail is long, in part scaly, with the distal underside naked, as in all

prehensile tails, that of the binturong being the only exception. The brain is very small, simple, and without convolutions. The species vary in size from that of a cat to that of a mouse. The teeth would indicate an insect eater, but as a matter of fact the family has become omnivorous, eating both animal and vegetable food. One aberrant species has taken to eating small fish, crustaceans, and other water animals, while another lives principally on crabs.

The Virginia opossum is the only species commonly found north of Mexico. It has been moving farther and farther northward until it has now reached the northern boundary of New York or even beyond, and far up into California. It is about the size of a large house cat, being the largest species of the family, a full grown specimen measuring about twenty inches in length of head and body, with the tail about two-thirds that length. The head and body are covered with coarse hair. There is also a moderately thick coat of under fur. The skull is characterized by the greatly developed ridges for the attachment of the muscles that move the lower jaws. The head is small and pointed, the ears large, naked, and leaf-like. The tongue is rough.

It is an animal of the forest, but takes well to the haunts of man, sometimes coming into towns and acting as a scavenger at night, retiring for shelter by day to the roofs of houses or into sewers. It is nocturnal in habits, coming out of its retreats to seek its food about sundown. I once saw one from a railroad coach in northern Indiana, late in the evening, standing with its head protruding from a hole in a tree at the ground level. The noise of the passing train did not seem to disturb it. But usually they are timid and shy in disposition and are rarely to be seen.

The female opossum, however, after the birth of her young, is quite pugnacious and will fight anything in defense of her babies. She prefers to fight with her back to a tree. She fights with her claws and teeth. She makes her nest on a bed of leaves in a hollow tree, log, or stump, in a crevice among rocks, in a hole in a cliff, or under some outbuilding. She is larger than her mate and when the young are in her pouch, she often drives him from their home. Birds and their eggs are their favorite food, but near farm buildings they frequently take heavy toll from the poultry yard. They are also very fond of papaws and persimmons. Under stress of circumstances they can live on frogs or insects. They will, too, root in the ground with their long noses for sprouting acorns. They often show great cunning in robbing hen roosts, but, on the other hand, they will stupidly walk straight into the simplest and most obvious trap, which is more in accord with their lowly brain structure.

When feigning death, or "playing 'possum," although usually timid, they will endure almost any amount of torture and give no sign of suffering. Except at the breeding season, the opossum leads a solitary life. It is naturally arborial, spending most of its time in the trees. The long prehensile tail is a sort of fifth hand, as in the spider monkeys, and the creature will often hang suspended by this member, or by the tail and one hind foot, or the hind foot alone,

for a long period. It has often been observed eating persimmons while hanging in this way. The tenacity of life is well known. Specimens have often been left for dead, their skulls broken or their bodies badly mutilated, but when the enemy was out of sight, they would get up and sneak away. It is almost impossible to kill one short of cutting off the head or drowning.

Mating is accomplished as in other mammals, the only peculiar feature being that both the male and female lie on the right side during the act, the male clasping his companion's body with his legs and holding her neck with his teeth.

The unfertilized egg of the opossum is only a little less than a pinhead in size, being much larger than the egg of a dog, many times larger than the human egg. It can be seen readily by the naked eye. I have seen the young attached to the nipple as small as a soup bean. It weighs only from three to four grains and resembles a bit of jelly in appearance. Even at this primitive stage the embryo is so tenacious of life that it would probably live two days should its mother desert it. The period of gestation is about eleven days only. The exact period is difficult to determine. In most mammals the fertilization of the egg follows the union of the sexes immediately or within a very short time, but in the marsupials ovulation may be delayed for a considerable time, even as long as six or seven days, but the time varies and may be less than this. It is largely because of the varying length of time between copulation and ovulation that the exact length of gestation of no marsupial is definitely known. In the case of the Virginia opossum ovulation takes place within three or four days after coition and the young are born from twelve to fourteen days from the date of copulation.

Heretofore it has been believed that at birth the marsupial mother transferred the young to the pouch, but within the last few years, at three different times and on three different continents, the birth of a kangaroo has been observed, and it is now known that the young, in this exceedingly undeveloped state, finds its own way, creeping slowly and clinging to the ventral hairs of the mother, into the pouch, unbelievable as it seems; and we now know, too, that the same is true of the opossum. Carl Hartman of the University of Texas, has recently published a paper on the breeding habits of the opossum. He says, "The young reach the pouch without the aid of the mother. These eleven-day-old embryos are born into the world with sufficient neuromuscular coördination and sensory response to clamber from the vaginal orifice into the pouch, find the teat in a maze of hair and attach themselves for a two months' stay at this haven of food and shelter. The writer witnessed this migration. The young appear at the genital opening and after being licked free of liquid and embryonic envelopes by the mother, they climb 'hand over hand' into the pouch. Because of the position of the mother during parturition, the young must climb upward to reach the pouch."

The mouth of the embryo forms a sort of tube into which the nipple of the mother fits. The lips grow fast to the nipple for a time, so that often in attempting to pull away the young, the head of the

embryo will pull off before the young can be detached from the parent. Milk is injected into the mouth by compression of the muscles covering the mammary glands. The young are born blind and deaf. But within a week their tails become prehensile enough to twine about each other's bodies. The mother is very careful of her babies, keeping the pouch constantly closed. In from five to six weeks the lips of the young lose their close connection to the nipple and they soon begin putting their heads out of the mouth of the pouch. At about the end of two months they begin to venture out of the pouch and to feed tentatively. It is not until they have grown to about the size of the rat that they remain outside permanently, for as long as they can get back when frightened they will rush into the pouch as a place of protection. When they are first able to leave the pouch the whole brood is often found on the back of the mother with their tails all curled about the tail of the parent, which, in turn, is twisted about a branch. In those species which have no pouch, this is the method of carrying the young from birth till they are able to take care of themselves. The Virginia Opossum breeds once or twice a year and may have as many as twenty-one young at a time. All young in excess of the number of nipples are doomed to death by starvation.

In order to study the habits of this interesting marsupial, I kept a specimen in my home for about four months. It was presented to me by my father on December 31, 1900, and I kept it to the end of April following. I named it Belshazzar, because it held a great revel at night. All day long it slept in the inner compartment of the cage, and was never seen or heard, but as soon as darkness shut down, it began clawing at the wire, scratching at the wooden sides, rattling the pan, and making all sorts of noises. I never saw any other animal of its size that could produce as much noise with such limited resources as this particular specimen of opossum. I had to put it in the farthest corner of the back hall down stairs, and even then sleeping in any part of the house was almost out of the question. Then, too, in spite of all precaution, it managed every now and then to break out of the cage, and when it did so, there was never any telling where to find it or what damage had been done. What with noise, frequent escapes, "tricks and manners," and what my wife said to me about it, those four months were not particularly serene and happy ones to me.

It was the noise and activity that brought the animal to a premature and untimely end. One Sunday morning it was missing. I hunted upstairs and down, in the closets and under the furniture, in every odd crevice and corner, but it was not till the middle of the afternoon that I finally located it in the center of a pile of extra quilts and comforts, fast asleep. By this time I was not in a particularly amiable mood and I went for my chloroform bottle. But so tenacious of life was it, that it did not yield to the anesthetic, but it was drowned quite readily. When I came to dissect it, Belshazzar proved to be a female, a fact which I had for some time suspected.

The specimen when received was, perhaps, about five months old and not more than half grown. She nearly doubled in size and

weight in the four months following. At death the length of body from tip of nose to root of tail, measured along the spine, was seventeen inches. Girth just behind forelegs, twelve inches. The body was covered with a moderately thick growth of fine woolly fur about an inch and a quarter in depth. This fur everywhere was studded with scattered coarse hairs ranging from an inch to three inches in length. They were shortest on the under parts and longest on the back and sides. These coarse long hairs were always white. The variations in color were due entirely to the fur, and to the tips of the fur only, for everywhere the fur was white next to the skin, even on the feet where the animal was the darkest. But there is also a black phase of pelage, in contra-distinction to the common gray opossum, on which these long overhairs are all black. It is but a color phase and occurs only about once in eleven specimens. Along the spine was a poorly defined stripe of very light brown, extending from the back of the head to the root of the tail. On the sides were several latitudinal stripes of the same color, very poorly defined. The limbs were dark brown to the toes, having but few of the long white hairs. The toes and the soles of the feet were pure white.

The head was almost entirely white. On the upper back part of the head, the outer end of the fur was a light brown, also on the back and sides of the neck. The ears were large and erect, but thin and mobile. In form they somewhat resembled a folded apple leaf, with the upper margin rounded. They were a dark slaty blue in color, except the tip which was white. There were but few of the coarse white hairs on the head. Vibrissæ were on cheeks and chin, many of them long and well developed, the snout produced to a considerable length and tapering almost to a point. The head was small in comparison to the body, the neck short and thick, limbs short, especially the forelimbs. The eyes are black.

The scaly tail was eleven inches in length. It tapered gradually to a point. It was covered with a sparse growth of short, fine, but bristle-like hairs. Near the tip it was almost completely naked. Near the root the scales were black, this color ending abruptly (but extending farther on the dorsal than on the ventral and lateral sides) in a dirty white, which latter, near the tip, faded into a pure white. On the dorsal side of the tip was a small brown scab-like thickening of the epidermis.

The opening of the marsupial pouch, when fully dilated, was about two inches in diameter and situated in the latitudinal center of the anterior of the abdomen. The interior was covered with a soft, yellow, woolly fur. There were thirteen nipples (the normal number) developed, six in each of two sub-semicircular rows, and one in the center. There are sometimes as few as eleven nipples and as many as seventeen.

I found the liver to be very large and divided into five lobes, three of which are large, the fourth much smaller, and the fifth only about half the size of the fourth. A gall-bladder is present. The digestive system is large and complicated, contrary to what one would expect in an animal so largely carnivorous. The stomach is large. The uterus is double, or, to be strictly accurate, there are two separate

and distinct uteri; there are two lateral vaginal canals connecting with the median vagina, into which the uteri open. The vagina proper, the urethra and the rectum all open into a short cloaca, there being but one posterior orifice in the marsupials. Cervical vertebræ, 7; dorsal, 13; lumbar, 6; sacral, 2; caudal, not determined. The epipubic bones were well developed and exactly an inch and a half in length.

I found this young opossum very timid at first, but when she was put in a large cage with plenty of room, she soon became savage. My father told me she would open her mouth and threaten to bite a common habit--but I need not be afraid of her, because it was all pretense. But one day when I was cleaning her cage, she did bite me. The gape of the jaws is very wide. She would bite savagely on the stick I used in cleaning her cage. It always made her angry to take out her bed. She constantly scratched and worked at the wires, and did her best to chew up her cage. She would brace her forefeet against the wire of the cage, take the wires of the door in her mouth and bite and pull viciously. During the four months I kept her, she never became gentle, and could not be handled or petted, but remained vicious to the end, except when taken out of the cage, when she lost all sense of bravery.

If I poked my finger at her to cow her when she was scratching at the wires of her cage, she gave utterance to low growls, very much like the growl of a small dog. Several times at night and once early in the morning I heard her make a peculiar vocal sound. It was something like "eh-eh-h-h-h, eh-eh-h-h-h, eh-eh-h-h-h." These were the only vocal sounds I ever heard her make.

She was very cleanly in her habits and it was no unusual thing for her to stop two or three times when eating a soft banana or any sticky or greasy food, and wash her hands. This she would do by licking them with her tongue. She would always wash her hands after eating. Now and then she would also wash her body. She would wash her coat where she could reach with her tongue. She would wash over her ear with her front paw. Then she would wet her right hind foot with her tongue and rub her side with this foot. Afterward she would wet the left hind foot and use it in the same way.

My captive opossum drank by lapping, turning the tongue up like a dog, and not under like the cat. In feeding, if the food was such as could be held in the hands, she always sat up and held it in this way, generally using one hand only, sometimes the right, sometimes the left, but occasionally she employed both at the same time. She was particularly fond of stewed chicken and fat meat, and of bananas, especially when they were fairly ripe, but she objected when they were soft enough to melt. She was also fond of bread smeared with lard or soaked in water. When hungry she would eat a lump of sugar, but did not care especially for it. When driven to it, she would eat hard crackers, but it was only when she was very hungry that she would do so.

When she was out of the cage she never ran and her walk was a peculiar waddle. Unsuccessful efforts were made to induce this

animal to hang by her tail, a recognized habit of opossums. While this may have been due to the fact that she had had no facilities for using the tail during the four months she had been in captivity, still it seems strange that a habit so ingrained should lapse in so short a time, even when held in absolute abeyance.

Attempts were also made to induce her to play dead, first by striking the floor near her with force, and then by hitting her quite hard, but all efforts were ineffectual. My father has told me that young specimens do not often "play 'possum."

I fed her but once a day and that in the evening, immediately after dinner. One night, to test her ingenuity, instead of feeding her in the usual way, I wrapped some bones and bits of meat in several folds of paper, but with no string, and put the bundle in the cage. She nosed around it for ten or fifteen minutes, then went back in a far corner and lay down. She slept for an hour or more. Then, as she had had nothing to eat for more than twenty-four hours, the pangs of hunger began to grow keen. She got up and worked at the paper till she found her way in to the meat. Even the lowly brain of the opossum can work out a new problem when driven by hunger. After all, an empty stomach is about the only inspiration that many of us know.

LECTURES IN SPRING COURSE, 1927

ZOOLOGY 3

PROFESSOR SCHMUCKER

A Biologic View of Man

Lectures begin at 8 P. M.

I. THE RACE

1. Monday, January 3.
   The Science of Man. The study of man's bodily characters—Anthropology. Manners and customs—Ethnology. Remains and workmanship of earlier man—Archeology.
2. Monday, January 10.
   The Higher Primates. The Java find (*Pithecanthropus*) and its intermediate position. The Piltdown skull (*Eoanthropus*) and its accompanying jaw.
3. Monday, January 17.
   The Earliest Men. The Heidelberg jaw. Neanderthal man: the first real man we know. His rude implements. Not our ancestor.
4. Monday, January 24.
   The First Men like us. Cro-Magnon Man and his noble structure. His finer implements. His artistic achievments. The Azilian transition.
5. Monday, January 31.
   Sweeping into History. Shell mounds and lake dwellings. Polished stone implements. Bronze and iron. Early centers of growing culture.
6. Monday, February 7.
   The Races of Men. The easy transfer of language and custom. The comparative persistence of bodily characters. Skin: hair: head form. Yellow, black and white man.
7. Monday, February 14.
   The three Types of European Whites. The blonde Nordic. The Alpine of mid-Europe. The Brunette Mediterranean. Their movements and fusions. The American Complex.

II. THE INDIVIDUAL

8. Monday, February 21.
   Coming into the World. The beginnings of human life. The awakening powers. The meaning of infancy.

9. Monday, February 28.
   Growing into Maturity. The ductless glands and their work. The development of sex. The part played by romance. The three great decisions.
10. Monday, March 7.
   The Full Tide of Life. The meaning of health. Our heritage of strength. Conserving our powers. Providing for the decline.
11. Monday, March 14.
   Making Way for Youth. The waning powers. The ripened mind. Its conservatism. Yielding to the new generation. The passage.
12. Monday, March 21.
   The Future Evolution of Man. Adaptation to environment. Gain and loss. Man's detachable organs - machinery. Rapid evolution without corresponding loss. Little recent physical change. Future advance chiefly intellectual, moral, social.

GEOLOGY 4

PROFESSOR TWITCHELL

Applied Geology—The Underground Treasures of the World

Lectures begin at 8 P. M.

1. Tuesday, January 4.
   How Underground Treasures Occur. Forms of ore masses and their relations to the rocks in which they are found. Theories in regard to the origin of mineral deposits.
2. Tuesday, January 11.
   Facts and Romance about Gold and Gold Mining. Gold mining in ancient times. King Tut-ankh-amen's golden treasures. Gold ores and mining methods. Gold "rushes." The greatest gold mines in the world.
3. Tuesday, January 18.
   Radium and Platinum and their Ores. The great radium ore mines of South Africa. The characteristics of radium minerals. The platinum deposits of Columbia, South America and the Ural region in Russia. The most costly of metals.
4. Tuesday, January 25.
   Treasures of Silver and Lead. The romance of silver in Mexico. Associations of silver ores with gold ores and lead ores, and of lead ores with zinc ores. Nuggets of pure silver. Famous silver mines of South America.
5. Tuesday, February 1.
   Underground Treasures of Copper. The three great copper regions of America. Copper ores; their beauty and diagnostic characters. "The iron hat" on a copper vein. Bonanzas due to enrichment by leaching and concentration. Copper in the "Age of Bronze."
6. Tuesday, February 8.
   Treasures of Tin and Aluminum. The famous tin placers of the Malay Peninsula. Where do our tin cans come from? Sources of aluminum. Other minor metals of interest and value.
7. Tuesday, February 15.
   The World's Treasures of Iron. Minnesota and other great iron ore districts. Iron and Civilization. Iron ores and how they occur.

   (Tuesday, February 22, no lecture.)
8. Tuesday, March 1.
   Clays as Underground Treasures. Why is clay imported from England to American potteries? Origin and properties of clays. Clays for special uses. The clay-working industries.
9. Tuesday, March 8.
   Stone, for Sculptor, Architect and Engineer. The famous marble quarries of Carrara, Italy, and limestone quarries of Indiana. Origin of different kinds of stone. Special properties of stone desirable for different uses. Other applications of Geology to Architecture and Engineering.
10. Tuesday, March 15.
   Underground Treasures for the Farmer. The nitrates of Chile, potash of Germany and phosphates of America. The search for potash in our own country. The minerals involved, and the character of the deposits. The great importance of these materials. Other applications of Geology to Agriculture.

11. Tuesday, March 22.
    Some Unique Underground Treasures. The Asphalt lakes of Venezuela. The Asbestos mines of Canada. The Sulphur mines of Louisiana. The Borax beds of California. The Graphite of Ceylon. The Monazite of Brazil.
12. Tuesday, March 29.
    Gems and Precious Stones. The great diamond mines of South Africa and ruby mines of Burma. Romance of famous gems. Gem minerals and their characteristics.
13. Tuesday, April 5.
    The World's Treasures of Coal. The greatest of all mineral industries. Pennsylvania's supreme position. Forms and other features of coal deposits. Varieties and distribution.
14. Tuesday, April 12.
    The World's Treasures of Oil. The great oil fields of America and elsewhere. The army of prospectors. Geological helps in the finding of oil. Theories of origin. High rank of the oil industry on basis of total value of world's output.
15. Tuesday, April 19.
    Prospecting for Underground Treasures. Hints on what minerals to prospect for, where to look for them, and how to estimate the value of any discoveries that may be made. The romantic side of the old prospector.
16. Tuesday, April 26.
    Underground Treasures and World Affairs. Who owns the Earth? The World's Race for Coal, Iron and Oil. Influence of mineral resources in world politics and diplomacy and in questions of war and peace.

PHYSICS I

PROFESSOR SEELY

Properties of Matter.—Mechanics

Lectures begin at 8 P. M.

1. Wednesday, January 5.
   Introduction. Physics defined. Matter and mass. Measurements of quantity, extension, and mass. Volume and density. States of matter. Time.
2. Wednesday, January 12.
   Motion, Velocity and Acceleration. Rectilinear, curvilinear, uniform and accelerated motions. Equations of motion. Simultaneous motions and velocities and resolutions thereof.
3. Wednesday, January 19.
   Newton's Laws of Motions. Force and momentum. First Law—inertia. Units of force. Second Law. Developments of the equation. Third Law.
4. Wednesday, January 26.
   Moments of Forces. Forces producing rotation about a point. Parallel forces. The couple. Concurrent forces. Composition and resolution of forces. Centripetal acceleration and circular motion.
5. Wednesday, February 2.
   Work and Energy. Units of energy, work, and power. Potential and kinetic energy. Transformation and conservation of energy. Matter and energy.
6. Wednesday, February 9.
   Gravitation. Newton's Law of Gravitation. Weight. Equilibrium and stability. Falling bodies.
7. Wednesday, February 16.
   Gravitation (Continued). Falling bodies further considered. Paths of projectiles. The pendulum.
8. Wednesday, February 23.
   Machines. Purposes of machines. Six simple machines. Principle of work. Mechanical advantage. Machine efficiency.
9. Wednesday, March 2.
   Machines (Continued). Friction. Thrust and tension on rods. Tension on cords.

10. Wednesday, March 9.
Liquids. Forces due to weight in liquids. Pressure in vessels of different shape. Liquids in communicating vessels.
11. Wednesday, March 16.
Liquids (Continued). Force transmitted by liquids. Pascal's Law. Hydraulic press. Artesian wells. Water motors. Hydraulic elevators, rams, etc.
12. Wednesday, March 23.
Liquids (Continued). Archimedes' Principle. Floating bodies. Specific gravities by Archimedes' Principle.
13. Wednesday, March 30.
Liquids (Concluded). Molecular forces in liquids. Cohesion and adhesion. Surface films. Surface tension. Capillary phenomena.
14. Wednesday, April 6.
Gases. Similarity and contrast between liquids and gases. Weight and density of gases. Atmospheric pressure. Barometers. Weather maps.
15. Wednesday, April 13.
Gases (Continued). Expansibility and compressibility of gases. Boyle's Law. Effects of temperature changes on gases. Atmospheric density and buoyancy.
16. Wednesday, April 20.
Gases (Concluded). Nature and Composition of the Atmosphere. Application of air pressure to machines. Pneumatic machines.

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BULLETIN

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CARL BOYER, Curator

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ANNOUNCEMENTS

THE fall courses of Lectures and Museum Talks closed just prior to Christmas holidays. Examinations were held on the subjects of the lectures on Botany, Inorganic and Organic Chemistry and Engineering. The attendance at all the instruction courses was excellent. Certificates of satisfactory service will be issued at the closing exercises in May next to all who have passed the examinations in proper proportion.

At the annual meeting of the Trustees some changes were made in official list, the most important being the abolition of the office of Chairman.

The lectures under the Westbrook foundation will be delivered in March. A syllabus of these will be found on another page of this issue.

The change of the course on Botany from the spring to the fall has been of considerable advantage on account of the availability of wild plants in bloom or in fruit during the period. The lectures have been liberally illustrated by growing specimens. This serves to awaken an interest in the attractiveness and use of our flora, and aids in the efforts now being made to preserve certain wild plants.

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RICHARD B. WESTBROOK LECTURESHIP FOR 1927
WAGNER FREE INSTITUTE OF SCIENCE OF PHILADELPHIA
Montgomery Avenue and Seventeenth Street, Philadelphia

FOUR LECTURES

AN INTERPRETATION OF ATLANTIC COAST SCENERY

ILLUSTRATED

By DOUGLAS W. JOHNSON, PH.D.
Professor of Physiography, Columbia University

FRIDAYS AND SATURDAYS, MARCH 4, 5, 11, 12, AT 8 P. M.

Admission Free

LECTURE 1: WAVES AND THEIR WORK.

Causes of wave motion; nature of wave motion. Waves of oscillation and waves of translation.

Intersecting waves. Groundswell and Surf, Swash, Backwash and Undertow.

Mathematical aspects of waves. Size and velocity. Destructive power. Tidal and other currents. Minor rôle of currents in shore development. The problem of coast protection. Its importance and complexity and the efforts to solve it.

LECTURE 2: THE EVOLUTION OF SHORE LINES.

A. *Shore Lines of Emergence.*

Young Stage: Offshore Bars, Lagoons and Salt Marshes; Tidal Deltas.

Mature Stage: Shore Cliffs; Betrunked Rivers; Hanging Valleys.

Old Stage.

B. *Shore Lines of Submergence.*

Young Stage: Islands, Peninsulas, and Bays; Bars, Spits, and Beaches.

Mature Stage: Old Stage.

LECTURE 3: IS THE ATLANTIC COAST SINKING?

AFFIRMATIVE EVIDENCE

Rapidity of Coast Erosion. Sinking of Dyked Lands. Encroachment of Salt Marsh on Uplands. Submergence of Tidal Mill Wheels. Submerged Stumps. Trees Killed by Encroaching Salt Water. Indian Shell Mounds below High Tide.

LECTURE 4: IS THE ATLANTIC COAST SINKING?

NEGATIVE EVIDENCE

Affirmative Evidence Explained. Variations of Sea-level Surfaces. Abandoned Marine Cliffs as Proof of Coastal Stability. Beach Ridges as Proof of Coastal Stability. Precise Level Surveys as Proof of Coastal Stability.

New Jersey Surveys. New York Surveys.

Legal Aspects of the Problem.

KEKULÉ AND HIS HEXAGON

HENRY LEFFMANN

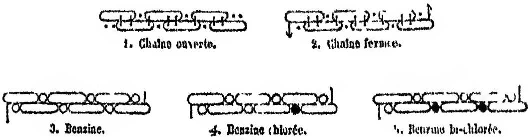
Few suggestions in theory have been more fertile in developing both pure and applied science than the suggestion of the six-carbon ring for the structure of benzene. The story of this hydrocarbon has a tinge of romance. It was first prepared in 1825 by Faraday, in the course of some investigation of compressed illuminating gas. He determined its composition to correspond to the formula C_2H ($C = 6$) and called it "bicarburet of hydrogen." Mitscherlich in 1834 obtained it by distilling calcium benzoate and called it "benzin." Later, A. W. Hofmann, working in England, found it in coal-tar. His pupil Mansfield prepared samples of it from that source. Mansfield lost his life in an accident while preparing a sample for exhibition at the Paris Exposition of 1854. The earlier workers overlooked the sulphur compound (thiophene) associated with it in tar and for some time the homologous hydrocarbons, such as toluene and the xylenes, were not clearly distinguished.

Before the middle of the 19th century organic chemistry had begun its phenomenal rise. The conversion of ammonium cyanate into urea had shown the inapplicability of the definition limiting organic chemistry to the products of vital action, and Berthelot's extensive researches in synthesis had widened the breach. Wurtz' discovery of the compound ammonias was a further important step. Berzelius' electrochemical theories seemed to be antagonized by the discovery of the comparatively easy substitution of the halogens for hydrogen in the hydrocarbons and their derivatives. The theory of hydrocarbon radicals grew into favor and then came, among other suggestions, the "type theory," which had an extensive and useful vogue. Most of the work concerned the series now termed aliphatic or open-chain, but experiments with benzene were carried out and somewhat enigmatical isomerisms began to appear.

Friedrich August Kekulé was born in 1829 and died in the summer of 1896. A summary of his scientific career and work is given in the memorial address delivered before the German Chemical Society at the meeting of July 27, 1896 (*Ber.*, 1896, **29**, 1971). His life, outside of his earnest and active chemical researches, seems to have been uneventful. As with many German chemists at that time and with some British and French chemists, attention was given to the theories of molecular structure. Three types of compounds were recognized under the "type theory" then in vogue: hydrogen, water and ammonia types. To these Kekulé added the marsh-gas type, and many aliphatic compounds were thus conveniently arranged.

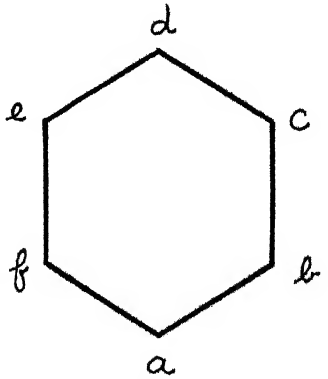
In 1858 Kekulé was called to the University of Ghent and began his most active work in organic chemistry, resulting in the publication in the early 60's of his text-book of organic chemistry. He developed the type theory, out of which grew naturally the doctrine of valencies. He suggested the tetravalent capacity of carbon and explained the formulas of the members of the open-chain homologous series by the self-saturation of the carbon atoms, in accordance with the methods now generally adopted and familiar to chemists.

The benzene derivatives could not be explained on the open-chain theory. In 1865, Kekulé prepared a paper which curiously was presented first to the Chemical Society of Paris, and read by Wurtz. The title was, "On the Constitution of Aromatic Substances." It covers about a dozen pages in the *Bulletin* of the society and contains adumbrations of the hexagon, bearing at first sight little resemblance thereto. Herewith are given reproductions of a few of



Kekulé's original stereochemic formulas as given in *Bull. Soc. Chim.*, 1865, n. s., 4, 108

the figures. It was really as far back as 1859 that Kekulé had suggested some phases of these stereochemic formulas. The paper on the constitution of aromatic substances was republished with material additions in *Annalen* (1866, **137, 1,** 129). The hydrocarbons of the aromatic series then known were usually referred to benzene as a type, and in addition to the formulas given above, he suggested the now well-known generally accepted hexagon, standing when unmodified for C_6H_6. The valencies in excess of those required for the hydrogen were disposed alternately as one and two between the carbons. We may note in passing what difficulty would have arisen if the old atomic weight of carbon on which Faraday based his formula had been retained, by which benzene would have been



Kekulé's suggestion of the hexagon as given in *Annalen* (see reference above)

$C_{12}H_6$. Kekulé's arrangements not only explained the structure of the homologues of benzene, but also showed the existence of three isomeric forms in all di-, tri- and tetra- substitutions, when the substituting radicals are the same. These views were put forth with caution and reserve that seem rather unnecessary at the pres-

ent time, but we are reminded of Darwin's caution and reserve concerning suggestions in the "Origin of Species."

It was in the paper in the *Annalen*, which, as noted above, was more extended than the original as read in France, that Kekulé made the suggestion of the hexagon, which was figured as above. It is worthy of note that it is a regular figure. For some reason chemists have fallen into the habit of making the two verticals longer than the other sides. To aid in explaining the isomerism, the letters were attached to the angles. A better system of numbers clockwise has supplanted this original suggestion.

Kekulé gives the following enumeration of the possible isomers in the successive substitutions of the hydrogen by one or more identical radicals, using the bromine substitutions as specific examples:

Monobromobenzene	one form
Dibromobenzene	three forms, *ab ac ad*
Tribromobenzene	three forms, *abc abd ace*
Tetrabromobenzene	three forms, similar to the di-forms
Pentabromobenzene	one form
Hexabromobenzene	one form

The hexagon is often written wrongly, groups CH being placed at the angles—such an arrangement represents *additive* compounds. The plain hexagon stands for C_6H_6. Hexagons are often shown with alternate double and single linkings, but this is also wrong. The exact manner in which the extra valencies are saturated is in dispute, and no theory in regard to it should be involved in the ordinary formulation of aromatic hydrocarbons and their derivatives. Full representation of the stereochemistry of any molecule cannot be shown except tridimensionally, that is, with models. For instruction at the Wagner Institute I prepared tetrahedrons of black cardboard, six inches on the side, with small hollow caps of different color which fit on the angles. By this means a very satisfactory explanation of the isomerisms can be shown.

A DIAGRAMMATIC REPRESENTATION OF HYDRION CONCENTRATION

MAX TRUMPER

The term hydrogen-ion concentration was introduced into chemistry a number of years ago, but has only in the last few years become familiar to physicians. It is commonly abbreviated by American writers as above (hydrion concentration).

One of the first difficulties with a subject of this type is the appreciation of the unit of measurement. In anatomy the student can note the general features with the unassisted eye. Even in histology and bacteriology we soon accustom ourselves to think in terms of microscopic measurements although we cannot actually conceive the small fractions of the inch or millimeter that are given. In dealing with atomic magnitudes and especially with the smaller

divisions, electrons and protons, there is a liability to lack of appreciation of the scale. The step from gross to cellular structure is short, indeed, compared with that to the realm of molecules, atoms and electrons.

It is necessary to change the basis of the unit of any scale in relation to the magnitudes measured. The mile suffices for ordinary land measure, the inch for many common objects, but the microscope deals with small fractions of this or with millimeters. In modern physical chemistry, higher mathematics finds very frequent application, and in expressing the degree of hydrion concentration a special application of mathematics is made, though fortunately not a very high phase

By hydrion concentration is meant the proportion of an acid or alkali in solution which has received electrical charges. Each acid and alkali, when dissolved or melted, suffers a change by which one part of its molecule assumes a charge of positive electricity and the other a negative. The two portions are termed "ions." The atom or group that assumes the positive charge is called the "cation" and the negatively charged one the "anion."

It is not intended here to explain at length the nature and importance of hydrion concentration, but to present a diagram showing concisely, and it is believed vividly, the relation of the acid and alkaline conditions and the nomenclature and notation of each step in the decimal increase or diminution of concentration. The symbol for hydrion concentration has been differently written, but American chemists are mostly agreed on pH and this form will be used here:

This number to express proportion is based on the fact that pure water under normal conditions ionizes itself, producing 1 gram of ionized hydrogen in 10,000,000 liters; in other words, 1/10,000,000 of the liquid is ionized. A numerical expression of this will be the hydrion concentration. The method adopted is to take the logarithm of this fraction. The logarithm of 1/10,000,000 is minus seven (−7). If the solution is ten times as strong, the logarithm would be −6, and so on. In practice, the minus sign is omitted, with the somewhat awkward result that as the amount of ionization increases the figure decreases, hence pH_3 represents a much stronger ionized solution than pH_7. Further, if the ionization of the hydrogen falls below 1 gram in 10,000,000 liters, it can be only by some increase of an opposing (negative) ionized atom or group. This is usually HO, the characteristic and active group of alkalies. In accordance with the above rule, this increase of negative ion diminishing the effective activity of the positive ion represents a greater dilution of the latter and hence a higher minus figure, but the minus sign being omitted as usual, the figure stands, for example, pH_8, which marks a diminution of the hydrogen-ion concentration by ten times that of pH_7. Proceeding in this way by adding substances containing hydroxyl ions, of which the common alkalies are the best representatives, we gradually reach a point in which the alkalinity is equivalent to and will exactly neutralize the hydrogen-ion concentration of pH_0. This alkalinity is represented by the figure pH_{14}.

The following synopsis shows this:

	pH_7 (Neutral) N/10,000,000	
Acidity		**Alkalinity**
pH_6	**N/1,000,000**	pH_8
pH_5	**N/100,000**	pH_9
pH_4	**N/10,000**	pH_{10}
pH_3	**N/1,000**	pH_{11}
pH_2	**N/100**	pH_{12}
pH_1	**N/10**	pH_{13}
pH_0	**N/1**	pH_{14}

Practically all the body fluids are represented by large unwieldy figures near the apex of this graph and so a short way of writing them is to use the negative power of ten to express the denominator. The abbreviation pH stands for the power (logarithm) of the number expressing the concentration of hydrogen ions. For example, the hydrogen-ion concentration of normal blood is about .000,000,04N, which in its abbreviated form is pH 7.39.

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ANNOUNCEMENTS

THE course on Zoology closed according to schedule with an excellent attendance. The courses on Geology and Physics will continue as scheduled and have so far shown entirely satisfactory interest. On account of the sudden death of Professor Twitchell, the course in Geology has been taken up by Dr. Howell, as noted below. Several extra lectures have been given and arrangements have been made to continue this feature. Mr. George S. Webster, of the Engineering Commission of the Delaware River Bridge, delivered a lecture on the methods of construction thereof. The work of improving the Institute grounds will be completed as soon as seasonal conditions permit. The building is being painted and incidental repairs made.

A volume of Transactions, reporting extensive studies of the biochemistry of the American pitcher plants, is about to be published. It was contributed by Drs. Joseph S. Hepburn and Elisabeth Q. St. John, and Mr. Frank M. Jones. The Westbrook Free Lecture Course for 1927 was given by Dr. Douglas W. Johnson, of Columbia University, on "An Interpretation of Atlantic Coast Scenery." Four lectures were given which were well attended.

Entered as second-class matter, September 10, 1926, at the Post Office, Philadelphia, Pa., under Act of August 14, 1912.

At a meeting of the Faculty, Professor Schmucker was re-elected President and Professor Griffith, Secretary. Dr. Twitchell presented to the Trustees, at their meeting of March 21, his resignation, to take effect at the close of the current scholastic year. The resignation was accepted and Dr. Benjamin F. Howell, of Princeton University, was elected to the chair, the title being changed to Geology and Paleontology. Owing to the death of Dr. Twitchell, Dr. Howell assumed the duty of continuing the course as scheduled. Mr. George B. Kaiser was elected Professor of Botany.

NECROLOGY

DR. WILLIAM HEALEY DALL, Honorary Professor of Tertiary Invertebrate Paleontology, died March 27, 1927. Dr. Dall was elected to Honorary Professorship on February 7, 1893, in recognition of his great services to science. In further acknowledgment of such services, the Trustees awarded to him a medal on June 7, 1899. DR. DALL contributed extensively to the Transactions of the Institute. Volume 3, in six parts, on the "Tertiary Fauna of Florida" and a note "On the Paleontologic Publications of William Wagner, founder of the Institute" are from his pen.

DR. MAYVILLE WILLIAM TWITCHELL was appointed Lecturer on Geology for scholastic year 1914–15, and was elected Professor of Geology and Physiography in April, 1916. He continued to conduct the courses in his department without interruption until his death on April 3, 1927.

A NEW METHOD OF STATING HYDROGEN-ION (HYDRION) CONCENTRATION

EDGAR T. WHERRY[1]

The total acidity or alkalinity of a solution, which may be determined by titration, is simply and conveniently expressed in terms of normality, or gram-equivalents per liter. For example, sulfuric acid, with the molecular weight of 98, is divalent, so that its equivalent weight is 98/2, or 49. A normal solution of this acid accordingly contains 49 grams per liter, a tenth normal solution 4.9 grams per liter, and so on.

When chemists discovered that in a given solution the amount of hydrion produced by the ionization of the acid is a matter of interest, attempts were made to state this also in normality terms. Hydrogen being a univalent atom with an atomic weight of practically 1, a normal solution of hydrion would contain 1 gram per liter. The amount of this ion present in the solutions ordinarily worked with being a very small fraction of a gram, abbreviated expressions, 5×10^{-6}, 8×10^{-3}, etc., were usually adopted. It requires, however, an undue amount of mental calculation to appreciate the relative values of hydrion concentration (normality) represented by a series of such terms, and the plan has been abandoned.

In 1909 Sörensen pointed out that the logarithm of the reciprocal of the hydrion normality is directly related to the electrical potential due to the hydrion, and suggested the use of the abbreviation *p*H for stating that normality. This is conveniently set in type as pH, and the numbers thus obtained are very simple. Because of its theoretical significance this method of stating hydrion concentration has come into general use by scientists.[2]

There are, however, several objections to this system of statement of acidity and alkalinity. The fact that the order of numbers is the reverse of that used in all ordinary methods of measurement is most serious. To have the greater acidity represented by the smaller number, as is the case in this system, is enough to preclude its ever coming into general use by laymen, who numerically vastly preponderate over scientists. Scarcely less objectionable is the fact that the numbers are related logarithmically instead of arithmetically. It is true that laymen use logarithms (without knowing it) when they say that a given person's income runs into seven figures, the 7 being the characteristic of the logarithm of the amount con-

[1] Former student and lecturer at the Institute; now Senior Chemist-in-Charge, Crop Chemistry Laboratory, Bureau of Chemistry, U. S. Department of Agriculture.

[2] Compare article by Trumper in this Bulletin (1927, 2, 53).

cerned; but it is not to be expected that they will be able to use the decimal portion or mantissa of a logarithm similarly. Few persons indeed, whatever their training, can recognize offhand that orange juice, with an average pH value of 3.6, is 8 times as sour as grape juice, with pH 4.5, yet the fact that these numbers are negative logarithms makes that the relation between them.

A further objection to the pH system of statement is that scientists not infrequently overlook the logarithmic character of the numbers, and perform operations with them, such as arithmetic averaging, plotting against arithmetic quantities, etc., which may lead to erroneous results or conclusions. Two instances may be cited. In a recent study[1] of the reaction preference of spinach, this plant was grown in solutions with the pH values 4, 5, 7, 8 and 9, and the maximum yield was obtained at pH 5, which was assumed to be its optimum soil reaction. However, the curve obtained by plotting the data, using arithmetical quantities on both axes, has a maximum at about pH 6.7, which is close to the neutral point, and therefore accords with the practical experience that this crop is markedly responsive to neutralization of the soil by lime. The experimental data were correct, but, as a result of overlooking the significance of pH values, an unwarranted inference was drawn from them. Again, as pointed out by Alexander,[2] in a recent elaborate work on the proteins, arithmetical data on swelling and other behaviors of gelatin were plotted against the logarithmic pH values, and the conclusion was drawn that this substance is a definite chemical compound which unites stoichiometrically with acids. A more judicious method of plotting would have shown this conclusion to be untenable. Moreover, it has become unsafe to judge the direction of changes in reaction from summaries or abstracts of papers, for some authors and abstractors say the hydrion concentration decreases when a solution becomes more acid, and others say that it increases.

My attention was directed in 1916 to the desirability of having a more readily understandable method of stating acidity and alkalinity when I undertook a study of the soil-reaction of a native plant, the Walking Fern (*Camptosorus rhizophyllus*).[3] Because of the considerations opposing the use of logarithms just discussed, I decided to adopt an arithmetical mode of statement. The antilogarithms of the pH values were, however, obviously too unwieldy. I therefore took the additional step of making the pH value at

[1] Agr. Expt. Sta. Mich. State Coll., *Techn. Bull.*, 1925, 71.

[2] Alexander, *Chem. Met. Eng.*, 1922, 27, 369.

[3] *J. Wash. Acad. Sci.*, 1916, 6, 72.

neutrality a starting point, which gave relatively simple numbers for the liquids (soil extracts) under investigation. Moreover, when a soil was acid it was so described, and when alkaline this was so stated, whereas in the pH system only acidity is considered, even in the most alkaline of solutions. I later discovered that a similar plan had been proposed four years earlier,[1] but had never come into sufficiently general use to have been mentioned in the reference works I had consulted. Analogous procedures were also worked out independently by Henderson[2] and by Tillmans.[3]

During the succeeding ten years I have endeavored to improve upon the original plan, partly in response to various published criticisms and partly as a result of constructive suggestions by colleagues. The form which the method has now taken on is as shown on page 62:[4]

In the first column of the table are placed the pH values, which represent electrical potential due to hydrion. They are negative exponential numbers. Accordingly, the greater the acidity, the smaller the number, while each unit is ten times as large as the next below. In order to have some means for grasping the relative degrees of acidity actually indicated by these numbers, those given in the second column have been calculated. The method by which they have been obtained is as follows: The amount of hydrion present in a liter of pure water—which can be determined by physicochemical measurements even though its tendency to produce acidity is neutralized by the presence of an equivalent amount of hydroxylion—is taken as a unit of acidity; it amounts to 0.0000001 gram. By the use of a table of logarithms, the quantity of these units represented by each successive pH number is calculated. From the total amount of hydrion thus calculated is subtracted the amount of hydroxylion which is also present, the one being the reciprocal of the other, and the result is rounded off to the nearest 0.5. This yields the amount of hydrion present in the solution, free to exert the effects commonly classed as acidity; and it is accordingly termed *active acidity*. These active acidity numbers are then not "percentages" or "degrees" but rather "acidity units per liter." They are directly related numbers, and if one solution is found to possess an active acidity of 500 and another an active acidity of 20, the first can be readily seen to contain 25 times as much active acid as the second.

[1] Walker and Kay, *J. Soc. Chem. Ind.*, 1912, **31**, 1013.

[2] Henderson, *Science*, 1917, **46**, 73.

[3] Tillmans, *Zeitsch. Nahr. Genussm.*, 1919, **38**, 1.

[4] Quoted from *Amer. Hort. Soc. Bull.*, 1926, **4**, 3.

pH	*Active acidity*	*Descriptive term*	pH	*Active alkalinity*	*Descriptive term*
3.0	10,000		7.0	0.0	Neutral
.1	8,000				
.2	6,300	(high)	.1	0.5	
.3	5,000		.2	1	
.4	4,000		.3	1.5	(l) (included
.5	3,150	Superacid	.4	2	in
.6	2,500		.5	3	Minimalkaline
.7	2,000	(low)	.6	4	circum-
.8	1,600		.7	5	(h) neutral)
.9	1,250		.8	6	
4.0	1,000		.9	8	
.1	800		8.0	10	
.2	630		.1	12.5	
.3	500	(high)	.2	16	(low)
.4	400		.3	20	
.5	315		.4	25	
.6	250	Mediacid.......	.5	31.5	Subalkaline...
.7	200		.6	40	
.8	160	(low)	.7	50	(high)
.9	125		.8	63	
5.0	100		.9	80	
.1	80		9.0	100	
.2	63		.1	125	
.3	50	(high)	.2	160	(low)
.4	40		.3	200	
.5	31.5	Subacid.......	.4	250	Medialkaline..
.6	25		.5	315	
.7	20		.6	400	
.8	16	(low)	.7	500	(high)
.9	12.5		.8	630	
6.0	10		.9	800	
.1	8		10.0	1,000	
.2	6		.1	1,250	
.3	5	(h) (included	.2	1,600	(low)
.4	4	in	.3	2,000	
.5	3	Minimacid.....	.4	2,500	Superalkaline
.6	2	circum-	.5	3,150	
.7	1.5	(l) neutral)	.6	4,000	
.8	1.0		.7	5,000	(high)
.9	0.5		.8	6,300	
			.9	8,000	
7.0	0.0	Neutral	11.0	10,000	

On the alkaline side of the neutral point, represented by the right-hand half of the table, the procedure is similar, but there are certain modifications. On theoretical grounds, the pH numbers are customarily given, even on the alkaline side, although here the effect of hydroxylion overbalances that of hydrion. As the amount of one ion present is always the reciprocal of the other, however, no difficulty is introduced into the calculations. Admitting the theoretical desirability of having a continuous series, I nevertheless feel that as soon as the reaction of a solution has been shifted any

distance to the alkaline side of the neutral point, it is the large excess of active alkali rather than the minor amount of acid still present which is biologically effective. Hence I prefer to use values for the *active alkalinity* on this side. The unit here is 0.0000001 gram-equivalent of hydroxylion per liter; as before, the amount of the other ion present in each case is subtracted, and the result rounded off.

Two sets of numbers are thus made available—pH for those who can use logarithms in mental calculations, active acidity and alkalinity values for those who prefer arithmetic. There is a third class of users who are not interested in any numbers. For them, the final column in each half of the table has been provided. Here the active acidities and alkalinities are described by a series of terms with a roughly quantitative significance. In brief, when a solution has an active acidity expressible in thousands it may be termed *superacid;* in hundreds, *mediacid;* in tens, *subacid;* and in units, *minimacid.* On the alkaline side corresponding terms are used. In some cases it may be desirable to divide each of these classes into two parts, in which case the division may be made at the numbers 30, 300, 3000, etc. A subacid solution in which the active acidity is less than 30 may be called low-subacid; one in which it is greater than 30, high-subacid, and so on. Finally, the following additional term is useful when dealing with solutions having reactions lying near the neutral point, where the changes from one tenth pH number to the next are so slight. Any reaction falling within the unit range on either side, where neither acid nor alkaline influences are markedly dominant, may be termed *circumneutral.*

In order to simplify the numbers as much as possible, the pH value of pure water at neutrality has been taken in the working out of my plan of reaction-statement, as exactly 7. It is realized, of course, that this depends on the temperature at which observations are made; varying the temperature one degree may make a distinct change in the second decimal place. Certain writers, impressed by apparent numerical precision, have in recent times stated that the pH value at the neutral point is 7.07, but they base this on a determination which is not necessarily final and was made at some arbitrary temperature (presumably 15°, although the importance of stating this is usually overlooked). Even if 7.07 is correct for 15°, then 7.00 is the value at 18°. If some future worker finds a different figure, however, I would urge that the temperature of reference be changed rather than the neutrality value.

Some critics point out that the pH system is almost universally

used among scientists, and that there is, accordingly, no need for another. To this I would reply that as scientists come to realize the need for making technical information more intelligible to the layman, new and improved methods of statement of data are sure to be developed. Others object to the division of the reaction-series into two parts at the neutral point. To this I have already replied,[1] pointing out that my plan is just as capable of being continued through the neutral point as is the pH system. There are, however, undoubtedly some cases where it is desirable to consider alkaline solutions to be alkaline, and then the neutral point forms the logical basis for the separation of these from acid solutions. As far as plant growth is concerned, it has recently been suggested by Olof Arrhenius[2] that hydroxylion may be as important as the hydrion, which has been almost exclusively considered heretofore. He, however, is not prepared to deviate from the pH method of statement, objecting to my plan in part as a result of taking more seriously than they were intended, some remarks of mine as to the ability of plants to recognize logarithms.

The disadvantages of this new method of stating reaction seem far outweighed by its advantages. The scientist can readily translate its terms into pH or any other sort of values when he so desires; the layman finds the reverse procedure difficult or in most cases impossible. The numbers, while slightly more complex than those of the pH system, do not often go beyond thousands in the ordinary solutions most likely to be met. This method recognizes the presence of both acidity and alkalinity, instead of emphasizing the one at the expense of the other. It is surely more desirable than a plan in which the relative magnitudes of acidity and the numbers expressing them run in reverse direction, and in which these numbers, being actually logarithmic, permit even prominent scientists to misinterpret experimental data by using them as if they were arithmetically related. In spite of the objections which have been raised against it, then, I still feel justified in urging the wider adoption of this new plan of statement of acidity and alkalinity.

[1] *Ecology*, 1923, 3, 346.

[2] Kalkfrage, Bodenreaktion und Pflanzenwachstum, Leipzig, 1926.

THE DUCTLESS (ENDOCRINE) GLANDS

The higher animals possess a number of glandular structures, such as the liver and pancreas, which have ducts and the functions of which are direct, especially in connection with digestion. Other structures of a glandular nature exist which produce no visible secretion, that is, none that flows into any mucous cavity of the body. The functions of the "ductless" (internal secretion) glands have long been problems, but extensive experimenting and clinical observation have cleared up much of the obscurity.

At a recent meeting of educators the "Schoolmen's Week Association," papers were read and discussed before the Section on Chemistry, Physics and Biology, in which the principal points concerning the functions of these glands were set forth. The meeting was held at the University of Pennsylvania, Dr. Wilmer Krusen, Director, Department of Health of Philadelphia, presiding.

Dr. Samuel T. Gordy, of the staff of the Philadelphia Hospital for Mental Diseases, read a paper on

The Endocrine Glands and Their Secretions

of which the following is an abstract:

Only in the past twenty-five years has sufficient knowledge accumulated on the basis of observation and experiment to give a fair notion of the functions of the glands of internal secretion. They are factories highly specialized for the manufacture of very potent substances that regulate the chemistry of our lives. Chemists have been able to make some of these artificially, for example, thyroxin, the active principle of the thyroid gland, and adrenalin, one of the active principles of the adrenal gland. In many instances chemists have been able to prepare from lower animals very potent extracts which replace the action of these glands when they are lacking, for example, parathyroid extract known as parathormone, pituitary extract known as pituitrin, and pancreatic extract known as insulin. The glands act as a biologic league of nations to keep our various functions harmonious. They act as the chemical twin sister to the nervous system in coordinating our bodily activities.

If there is not enough thyroid in early life, dwarfism and idiocy result. Several grains of dried thyroid will convert a thick-lipped, pot-bellied, heavy-featured, idiotic cretin into a well-proportioned, normal, alert child. Thyroid also regulates the production of animal heat, in other words, regulates the draught of the furnace of life.

The adrenal glands, one above each kidney, manufacture adrenalin. It is a sort of energizing principle enabling us to do physical work and combat fatigue with greater efficiency. It operates when

the organism is under special stress to mobilize all the body forces calculated to fit the animal for putting up a good fight or run from its enemies. It is the gland of combat or flight. Endurance is not only a matter of strong muscles and good wind--it requires good adrenal tissue.

The parathyroids regulate the amount of lime salts in the blood. If they are removed the animal will go into convulsions, which may be promptly relieved by the use of parathyroid extract.

The pituitary, located at the base of the brain, has much to do with our height, weight, and general contour. The seven- and eight-foot giants that we see in the circus and read about all had an excess of pituitary secretion in their early teens. Certain types of fatness are due to disturbance of this gland. The changes in Napoleon from the thin artillery officer to the rather rotund emperor were probably due to pituitary disfunction. Dickens in "Pickwick Papers" gives us a typical picture of pituitary disease in the fat boy who always fell asleep. When the ground hog goes into winter quarters, the pituitary is taking a vacation.

From the pancreas or sweetbread, insulin is obtained, a constant supply of which is necessary to keep us all from becoming sufferers from diabetes. When our own supply fails, we can now, thanks to the remarkable work of Banting and Best of Toronto, supply our deficiency from insulin obtained from lower animals.

Our latter day Ponce de Leons who are looking to reclaim their lost vigor and youth by various rejuvenation operations and monkey gland transplantations have not been pre-eminently successful in their search, despite early, much touted claims.

Richet says, "The living being is a chemical mechanism and perhaps it is nothing more." Modern biophysics and biochemistry show more and more how our daily life is subject to the influence of general laws that operate throughout the whole of life. There is a great wilderness of ignorance to be explored. Only the fringe of the virgin forest has been cleared, and we are still in the pioneer days of discovery. Perhaps some day what we call personality will yield to strict scientific measurement.

Abstract of a Discussion on "The Internal Secretions and Human Behavior," by Dr. Henry E. Starr, Department of Psychology, University of Pennsylvania.

The realization of the importance of internal secretions may be said to date back 400 years ago to Paracelsus, who observed that the well being of the human organism depends largely upon the nature of the material "distilled" from one organ into another.

The development has been slow. Today there is a tendency to think we know more about the subject than we do. For there is wide circulation of popular treatises on the glands, which are replete with misinformation and romantic fiction.

The sympathetic nervous system, involving as it does the glands of internal secretion, is the most primitive part of man's nervous organization, and with it are interwoven the primordial determinants of all behavior—motivation and available energy. With the latter, the thyroid has, directly, much to do. Upon the adequate functioning of this gland depend, to a large degree, the alertness of the individual, his capability for intellectual effort and intelligent performance, etc. The parathyroids appear to function normally as stabilizers of the performance level. The pituitary, with its dual structure and manifold functions, is psychologically a fascinating mystery. So also is the thymus, the so-called "gland of childhood," which has not been definitely proven to secrete anything. As to the adrenals, the effect is to give the individual more immediately available energy in times of stress.

All of the glands thus far studied are most closely interwoven in chemical and functional relationship. Research on metabolism and behavior in the Psychological Clinic of the University of Pennsylvania, with especial reference to hyper-excitable children, indicates the importance of the adrenals in many such cases, as well as involvement of the thyroid.

There must be an adequate synchronization of all of the glands for the production of normal behavior. Just as there is a psychology of individual differences, known as clinical psychology, so there are also a biochemistry and an endocrinology of individual difference being developed. Each must be employed in connection with the other that the aim of Orthogenics may be attained—"the normal development of every child."

NOTES ON THE FUCHSIN-SULFUROUS ACID TEST

HENRY LEFFMANN AND MAX TRUMPER

This test has acquired much importance of late years from its use in the official process for detecting methanol, which is liable to be present in alcohol recovered from the commercial denatured form. The procedure given in the current U. S. Pharmacopeia (X) is based on the comprehensive investigation by LaWall (*Trans.*, Wagner Free Inst. Sci., 1923, **10**, 55; reprinted in *Amer. J. Pharm.*, 1923, **95**, 812). The procedure has given entire satisfaction, but LaWall found that glycerol will respond to the test and, therefore, in dealing with alcoholic liquids other than plain spirits, distillation is necessary (*Amer. J. Pharm.*, 1924, **96**, 226).

The fact that a rosaniline salt bleached by sulfurous acid will acquire a deep color by action of aldehyde was first pointed out by Hugo Schiff in a comprehensive paper in *Ann.*, 1866, **140**, 132. The reaction for the bleaching was given as follows:

$$C_{20}H_{19}N_3 + H_2SO_3 + H_2O \rightarrow C_{20}H_{21}N_3 + H_2SO_4$$

The color of the dye is not restored, but a deep characteristic color is formed which makes the test very delicate. Formaldehyde, for the detection of which the test is now mostly employed, was not known when Schiff published his paper, having been first produced by A. W. Hofmann in 1867 (*Proc. Roy. Soc.*, 1867–68, **16**, 156; also *Chem. News*, 1867, **16**, 285). In 1914, H. Fincke published in *Zeitschr. Unter. Nahr. Genuss.* (1914, **27**, 246) the results of investigations that led him to modify the method of preparing the bleached rosaniline solution, claiming that the new formula gives a reagent specific for formaldehyde. The formula has, in fact, undergone a number of modifications, but the main features have been preserved, being the production of a leucaniline by the hydrogenation (reduction) of the dye as shown above. The common salts of rosaniline—acetate and hydrochloride—are used in preparing the reagent. Some formulas prescribe sodium sulfite, some the acid salt. Fincke claimed special advantage in the use of a much larger proportion of hydrochloric acid than in the solutions as commonly made up, and also as an item not to be overlooked, the addition to the solution to be tested of from 1 to 2 c.c. of the same acid before adding the reagent. Sabalitschka and Harnisch, in a recent long and very thorough review of the tests that have been proposed for formaldehyde, name Fincke's method as characteristic. It is stated that even if acetaldehyde produces a color, it fades in a few hours while that of formaldehyde remains for a long while.

Fincke's application of the solution and the investigation by

Sabalitschka and Harnisch relate entirely to the detection of formaldehyde ready-formed as in foods by addition thereto, but the inquiry here presented is the use of the solution as the final procedure for the detection of methanol by the standard oxidation process, which is in this country, at least, the most frequent requirement. Comparisons have been made with solutions prepared according to U. S. P. IX and X, and Fincke's suggestion.

U. S. P. IX

Fuchsin	0.5	gm.
Sodium acid sulfite	9	"
Water	500	c.c.

To this solution add 10 c.c. of hydrochloric acid, sp. gr. 1.12.

U. S. P. X

Fuchsin	0.2	gm.
Hot water	120	c.c.

after the dye is dissolved, cool the liquid and add

Sodium sulfite (dry)	2	gm.
Water	20	c.c.

Then 2 c.c. of hydrochloric acid, sp. gr. 1.12 and dilute the liquid to 200 c.c.

Fincke's reagent:

Fuchsin	1	gm.
Sodium sulfite (dry)	12.5	"
Hydrochloric acid (1.12)	15	c.c.

These substances are to be dissolved in 500 c.c. of water and then diluted to 1000 c.c.

The solution at first colored soon bleaches and is ready for use. It is stated to keep well in closed containers.

From 1 to 2 c.c. of hydrochloric acid (1.12) must be added to the liquid to be tested before the reagent.

Tests have been made by us on dilute solutions of ethanol, methanol and glycerol, with the three reagents. The change of formula of U. S. P. IX to that of U. S. P. X is stated to have been made to conform to the reagent recommended by the A. O. A. C., but that reagent is directed to be made with a solution of sulfurous acid of definite strength. Solution U. S. P. IX has seemed to us more satisfactory than that directed by X, being more rapid in reaching a straw yellow and keeping very well even under ordinary laboratory conditions. Fincke's reagent, as noted above, is stated to give no color, or only a transient one, with acetaldehyde, but a permanent one with formaldehyde. This has been confirmed, and in applying the test to ethyl alcohol according to the procedure of X no color was obtained with the Fincke's reagent, but a small amount

of glycerol without either methanol or ethanol gave a very distinct blue which would be, of course, mistaken for the methanol reaction. It appears, therefore, that while Fincke's reagent has some advantages it does not eliminate the fallacy which LaWall discovered, and distillation of alcoholic liquors is necessary, except when plain spirits are under examination.

Research Laboratory
Wagner Free Institute of Science of Philadelphia.

CLOSING EXERCISES

The formal closing exercises for the scholastic year 1926-7 were held in the hall of the Institute on Wednesday, May 11, 1927, at 8.15 P. M. in the presence of a large and interested audience.

The proceedings were opened by a short address by Professor Samuel Christian Schmucker, President of the Faculty, who called special attention to the fact that the session just closing had been the most successful for many years, both as to the attendance on the instruction and the interest and efficiency of the students. The attendance on the Museum Talks had been especially large.

Following Professor Schmucker's remarks the members of the Faculty announced the names of those who had been awarded certificates in the several branches.

The exercises closed with a lecture on "Dust" by Paul Q. Card, B.S., Instructor in Technical Chemistry in the Philadelphia College of Pharmacy and Science.

The manifold dangers of dust both in general and in industrial plants were pointed out, and the explosive character of many forms explained.

The relation of dusts to fogs and storms was also noted.

A list of the students receiving certificates is herewith given.

The scholastic year 1927–8 will begin about the middle of September. Details will appear in the August issue of the BULLETIN.

FULL TERM CERTIFICATES

Engineering.—Abraham Agatstein, William Hain Lengel.

Botany.—Hugh F. Munro, Jr.

Zoology.—W. Henry Sheak.

Geology.—Frank E. Draper, George T. Faust.

1926–27 CERTIFICATES

Engineering 4.—Abraham Agatstein, Emanuel Hocking, William Hain Lengel, Monroe Lesher, George N. Meyers, Andrew Pataky, Albert Rochelle, Charles H. Seidel.

Botany 4.—William B. Bruce, Henry L. Burr, Louis G. Dietz, Jr., Frank E. Draper, Mrs. Marie S. Duffy, Emma Garman, H. May Hunter, Carlotta Lowber, Blanche McNeill, Milton K. Meyers, Hugh F. Munro, Jr., Mrs. Thomas Peacock.

Inorganic Chemistry 2.—Leonard Coggin, Joseph Creely, James J. Deeney, Frank E. Draper, Abraham Josel, William Josephs, H. J. Magnin, Milton K. Meyers, Joseph Popel, Manuel Tubis.

Organic Chemistry 2.—William B. Bruce, Leonard Coggin, Joseph Creely, James J. Deeney, Walter F. Estlack, Jacob Gordon, William Josephs, Milton K. Meyers, Manuel Tubis.

Zoology 3.—Henry L. Burr, Louis G. Dietz, Jr., Walter F. Estlack, Dorothy B. Gillette, Edward H. Gillette, William D. S. Gillette, H. May Hunter, Carlotta Lowber, Blanche McNeill, Milton K. Meyers, W. Henry Sheak.

Geology 4.—Frank E. Draper, George T. Faust, Dorothy B. Gillette, Edward H. Gillette, William D. S. Gillette, Alfred D. Hills, D. Brooke Johnson, Milton K. Meyers, Harold Poole, Carl H. Wolff.

Physics 1.—Frank E. Draper, James J. Deeney, Dorothy B. Gillette, Edward H. Gillette, William D. S. Gillette, Cedric Haring, Daniel A. McKim, Victor H. Sparrow.

Museum Talks.—Henry L. Burr, Louis G. Dietz, Jr., H. May Hunter, Carlotta Lowber.

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Montgomery Ave. and Seventeenth St., Philadelphia, Pa., U. S. A.

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BULLETIN

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WAGNER FREE INSTITUTE OF SCIENCE OF PHILADELPHIA

PUBLISHED BY THE INSTITUTE

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Associates in Editorship

SAMUEL T. WAGNER, B.S., C.E., President of the Institute

CARL BOYER, Curator

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ANNOUNCEMENTS

THE courses of lectures and series of museum talks began with satisfactory attendance. Schedules of these are given in the August issue of the BULLETIN, copies of which can be had by application at the office of the Institute.

The improvement of the Institute grounds has been very satisfactory and has attracted much attention. The building has been painted, and further work in improvement will be undertaken soon.

The Westbrook Lectures for 1928 will be given in March by Dayton C. Miller, D.Sc., Case School of Applied Science, on "The Science of Musical Sounds." Four lectures will be given, a detailed syllabus of which will appear in a future issue of the BULLETIN.

Arrangements will be made for special lectures on subjects of general scientific interest, announcements of which will be made from time to time as definite appointments are determined.

Entered as second-class matter, September 10, 1926, at the Post Office, Philadelphia, Pa., under Act of August 24, 1912.

Wild flowers are not usually seen in the Institute grounds, but this year a harbinger of autumn appeared among the new shrubbery in the form of a tall golden rod, waving its yellow tops in the wind. It was determined by Professor Kaiser, *Solidago serotina* Ait.

The genus *Solidago* is eminently North American, many species being known. They offer considerable difficulty in distinguishing, either because of great tendency to variation or facility of hybridization. Notwithstanding their somewhat showy blooms, they are apparently not much visited by the usual pollinating insects, and the pollen is blown more or less about by the wind, causing irritation to many persons. The close approximation of the flowers in heads facilitates cross fertilization.

Some years ago, when an exchange of plants was arranged with Mr. Ising in Adelaide, South Australia, a special request was made by him for specimens of golden rod. A number of carefully determined specimens were sent and he afterward wrote that these had been exhibited at two public meetings and had attracted much attention. The genus *Aster*, which is also a noticeable feature of eastern North America, is not directly represented in Australia but a closely allied type, *Olearia*, is familiar.

By means of exchanges arranged some years ago the Institute has secured a number of plants characteristic of the antipodes. Recently Mr. R. M. Laing, of Christchurch, New Zealand, sent the following specimens. Southern New Zealand is partly mountainous and, of course, the colder portion.

Helichrysum microphyllum Benth. and Hook f.

Helichrysum bellidioides Willd.

Haastia sinclarii Hook f.

Cotula atrata Hook f.

Raoulia australis Hook f.

Leucogenes grandiceps Beauverd.

NOTES ON REINSCH'S TEST

HENRY LEFFMANN AND MAX TRUMPER

Many scientists have obtained immortality simply by their names being indissolubly connected with some procedure, apparatus or phenomenon. Baumé, Nicol, Fehling and Kjeldahl are familiar instances. Soxhlet has undeserved and unsought fame, for the useful extraction apparatus was devised by an assistant, Szombathy, as Soxhlet states in a communication (*Ding. Polyt. Jour.*, 1879, **232,** 461). Bunsen is not a case in point, for while his burner is so familiar that his name is often spelled with a small "b," his work on the kakodyl compounds and in spectroscopic and gas analysis is widely known.

Hugo Reinsch was a chemist who contributed considerable information, but his name appears in modern literature only in connection with a test. Witthaus and Wormley, in their respective works on toxicology, give 1843 as the year of the publication, but this date refers to a book on arsenic. The original publication was in *Jour. prakt. Chem.*, 1841, **24,** 244. He discovered the reaction by accident. Boiling a copper slip with commercial hydrochloric acid he noted a discoloration and on investigation found that the acid contained arsenic. We might speculate on what delay would have happened in the introduction of this test if the acid had been pure. The reaction suggested trials with other metals and the paper contains the results of numerous experiments. In modern use the test is practically limited to detection of arsenic, antimony and mercury, particularly the first named.

The test has not received the attention from toxicologists that it deserves. This has been largely due to a lower delicacy than some of the other tests, especially Marsh's and the modifications thereof, depending on the production of hydrogen arsenid. In the detection of very minute amounts of arsenic and antimony, Reinsch's test is not satisfactory; but in dealing with ordinary cases of poisoning, it serves a very useful purpose, because it can be applied directly to almost all materials that may be presented to the toxicologist, such as secretions and excretions, vomited matter, viscera, foods and beverages. Preliminary destruction of the organic matter is not required.

The coating on the copper is fairly characteristic when the metal is present in the pure state, but in the ordinary application of the test, confirmation of the nature of the deposit must be made. This is fortunately easily carried out as far as regards arsenic, antimony and mercury, which are the elements with which the toxicologist is almost exclusively concerned in connection with the test. The copper slip, washed and carefully dried, is rolled into a small mass and heated gently in a small glass tube closed at one end. Arsenic sublimes and oxidizes to arsenous oxid, which deposits on the cooler portion of the tube in brilliant octahedral crystals. Mercury passes into vapor without oxidizing and collects in mirror-like globules. Antimony on strong heating gives a sublimate which shows needle-shaped forms in part, but under moderate powers is largely amorphous.

The production of octahedral crystals was long considered as definite evidence of arsenic, but in 1877 Dr. Wormley communicated to the *American Journal of the Medical Sciences* the results of numerous experiments in which distinct octahedral crystals had been obtained with pure antimony compounds. This communication is republished in *Amer. Jour. Pharm.*, 1880, **52**, 195. It appears that strong heating and moderate exposuie to air were employed. This is not the proper method of testing the slip. It should be heated with a spirit lamp and in a narrow tube closed at one end. Under these circumstances the formation of brilliant octahedral crystals without appreciable deposit of another character will be proof of arsenic. The size of the crystals may be increased if the part of the tube just above the copper slip is slightly warmed. This causes the vapor to crystallize rather slowly, which is always favorable to better forms. Reinsch calls attention to the difference between the deposit of antimony and arsenic on the copper, but he did not report any test by sublimation. It is true that by using pure materials an appreciable difference can be noted in the deposits, but in toxicologic work such difference is often lacking and the sublimation procedure should be employed.

In the practical application of the test, the materials used can be submitted to perfect control, by the following method:

Pure thin copper foil, about 3 cm. long and 1 cm. wide, is introduced into a test-tube about 10 cm. long and 2 cm. in diameter. A mixture of pure water with about 10% of pure hydrochloric acid (1.12) is added and the mixture boiled gently for a few minutes. No color should be deposited on the copper. If the metal was somewhat tarnished, it will, of course, brighten by this treatment. By this preliminary test the purity of the acid and copper can be established. A small amount of the solution to be tested is then introduced. Ordinarily there will be no foaming, but care should be used in making the addition. In the presence of even small amounts of such metals as arsenic, antimony, mercury and bismuth, a coating will soon form on the copper. It is of little value to examine this coating, as the subsequent treatment will give more satisfactory results. The slip is removed, washed with pure water and dried with filter paper, or it may be dried on the water-bath. It is rolled up or cut in strips and introduced into a clean glass tube which is sealed at one end, the copper being pushed down close to this end, which is then heated gently by a spirit lamp. Bismuth gives no sublimate, mercury produces globules, antimony gives no appreciable effect, unless the heating is long continued, which should not be. In the presence of appreciable amounts of arsenic, the crystals of arsenous oxid can be seen by the unaided eye, but examination with very low powers will show the characteristic forms.

The entire amount of the several metals that respond to this test can be removed from a solution by it, but this is not usually advisable. The crystals of arsenous oxid can be driven back and forth in the tube by gentle heating and thus their nature still further indicated.

Reinsch made some comparative quantitative experiments and stated that the test was as delicate as any then in use, but Wormley did not get such results. It is true that in comparison with the tests introduced in recent years and intended for the detection of the minute amounts of arsenic which are liable to be in foods, beverages and drugs, the test is inferior and, indeed, not applicable, but for preliminary examination of materials submitted in such cases of suspected poisoning it is very useful.

The metals less positive than copper are precipitated without the addition of acid, but in many cases the action is hastened by slight acidification. Arsenic is almost always encountered in the negative ion (as arsenite), and action of the strongly ionizing halogen acid is needed to bring it into such relation to the copper as will permit the latter to substitute it. Arsenates do not react well, but large excess of acid will enable some result to be obtained. Oxidizing substances, such as potassium chlorate, interfere completely. Antimony is usually encountered in toxicology in the positive ion, since tartar emetic is the familiar form.

The neglect into which the test has fallen is shown by the fact that it is not mentioned in Autenrieth's manual, which is one of the most popular guides in toxicologic analysis, in its original and translated forms. Trumper's "Memoranda of Toxicology," however, describes the test in detail, with the necessary precautions.

Chemical Laboratory,
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ANNOUNCEMENTS

THE courses of Lectures and Museum Talks have been continued through the session with satisfactory attendance. The lectures on Botany, Inorganic and Organic Chemistry were finished as scheduled. The course on Engineering continues until just before the holidays.

As announced in the October BULLETIN, the Westbrook course for 1928 will consist of four lectures on the "Science of Musical Sounds," by Dr. Dayton C. Miller, of the Case School of Applied Science. A syllabus giving full information of the course will appear in the February BULLETIN.

Numerous additions have been made to the collections of the Institute and property improvements have been also carried out.

Entered as second-class matter, September 10, 1926, at the Post Office, Philadelphia, Pa., under Act of August 24, 1912.

PERSONAL NOTE

A comprehensive paper on the fauna of the Upper Mississippi River, contributed by Dr. Norman N. Grier and Mr. R. B. Tweedy, appears in this issue.

Dr. Grier is a graduate of the University of Pittsburgh, and pursued additional studies at several other colleges, including Yale and the University of Paris. He was for some years Assistant Professor of Evolution at Dartmouth College, but in 1926 accepted appointment for two years as Professor in the Biological Department of Des Moines University with freedom to teach evolution in the Biological Sciences, where he discharged with entire satisfaction his duties during the session of 1926–7.

At the close of this session the institution passed into the control of the Baptist Bible Union of America and steps were immediately taken by this organization to eliminate all teaching at variance with the Biblical story of creation, and to prevent any teaching that would lead to the view that man is related by descent to the lower animals. Dr. Grier having frankly expressed his disbelief in the creation story as given in the early chapters of Genesis, was compelled to resign. Similar eliminations were carried out with other teachers. The Dean of the School of Pharmacy, who had been in charge for many years and had contributed largely to its success, was dismissed because he is a Unitarian. In all about a score of competent teachers were removed on account of their opinions concerning evolution and allied questions.

Dr. Grier is now at the State Teachers College at West Chester, Pa.

Mr. Tweedy is a senior student at Dartmouth College.

THE FAUNA OF THE SANDBARS OF THE UPPER MISSISSIPPI RIVER *

By

N. M. Grier

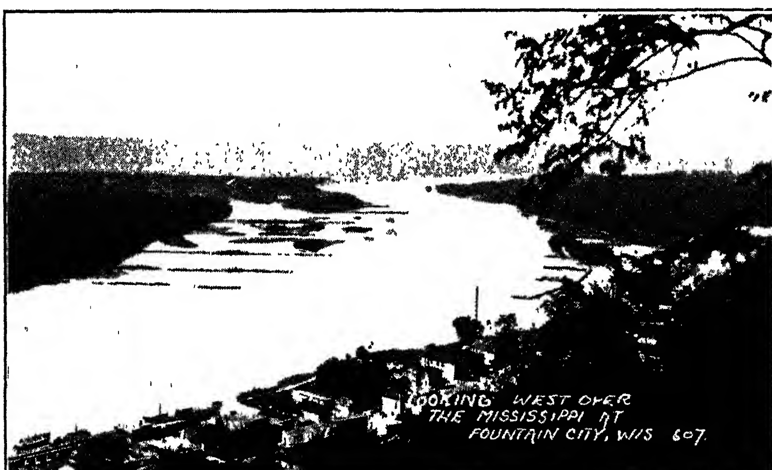
State Teachers College, West Chester, Pa.

and

R. B. Tweedy, '28

Dartmouth College

The upper Mississippi River flows in soft, easily eroded deposits, and since the volume and velocity of the stream are frequently subject to change, for example, in flood time, there will be corresponding differences in the amount of scour and deposition at any given point. However, there are certain places where deposition is so constant that extensive accumulations may be formed. One instance is where the velocity of the stream meets a constant check through obstructions in the river bed, and as a result there follows the more or less rapid formation of sand and mudbars. The river viewed as a whole is then seen to



The illustration shows the Upper Mississippi River in Wisconsin and Minnesota. Center background, old bars which have become covered with willows. Right background, rock rip-rap with which the bank of the current side is protected. Right foreground, a dam partly closing off a slough. Behind the dam a well-wooded island has been formed. Left foreground, the wing dams with the sand bars in various stages of evolution rising between them.

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* This article was on the program of the Ecological Society of America at its Washington meeting, December, 1924. Contribution No. 9 from the Department of Evolution, Dartmouth College. Courtesies extended by the U. S. Bur. of Fisheries during the observations are gratefully acknowledged.

consist of alternate pools, 10–20 feet in depth and shoals which, before engineering improvements were made, had a depth of only one or two feet. The pools occur in the bends and are the site of formerly extensive mussel beds. The shoals or bars in which we are interested are in the straight reaches where the channel crosses from one bank to the other. On this account such sections of the river are known to river men as "crossings."

The sand or mudbars exhibit a gentle slope on the upstream side, but end more abruptly down stream. They advance by having sand or gravel pushed up the gentle slope by the current and dropped over the steep face, where it forms inclined layers. During floods, large additional quantities of material are thrown down, and when the stream is subsiding, this sand, mud or fine gravel tends to assume a more horizontal direction, giving an irregular or confused stratification when seen in section. As one approaches the sandbar from the edge of the channel the depth of water suddenly decreases at a point a variable distance from the edge of the bar. This point may be termed the *reef*, while that deeper portion of the river bed adjoining the reef, and into which one may unwarily plunge, is called the *step-off*. It is directly continuous with the deep water at the lower or down-stream edge of the sand bar.

In a few places, the natural growth of sandbars already in existence has been hastened through deposits of sand pumped from the main channel by government dredges. Of more recent years, entirely new mud and sandbars have been built up artificially through government work in improving the river channel. Low dams of rock and brush (wing dams) are built out from one or both banks, after the channel has been cleared by snagging or dredging. Banks subject to attack by erosive currents are protected by means of rip-rap. These improvements increase and control the velocity of the current in the main channel and thus keep it open for navigation, while the current whirling behind the dams carries the sediment already in suspension toward the shore, where it is deposited between them. In this manner the bottom is gradually built up to the level of the water, increasing with successive floods. Fishermen finding these dams points of advantage from which to practice their art are a familiar sight from trains traversing this region. Older dams afford a footing for willows and cottonwoods, whose seeds are brought to them during the high water of the spring. Frequently mud from more easily eroded portions of the river is deposited upon both types of bars by changing currents. This determines somewhat the kinds of animals and plants which may inhabit those bars, and affects their relationships with one another.

It will at once be seen that the sand and mud bars are a natural repository for the detached masses of water plants which are swept along by the current. Included in these are the water weed, (*Elodea* sp.); the horn-wort, (*Ceratophyllum*); the pond weed, (*Potamogeton* sp.); the ditch grass, (*Ruppia*), and *Naias*. Often found associated with these are various fresh water Crustacea such as *Gammarus* sp. and *Hyalella knickerbockeri* Bate. While these water weeds persist only infrequently on sand bars, they become more abundant on those bars where mud has been deposited, for there they more readily take root and grow. They then become important agents in elevating the bar above the surface of the water on account of the sediment they catch. One may often

observe hovering over them the bright blue damsel fly, *Enallagma civile* Hagen, and many different kinds of dragon flies, among which are the brown forms *Epicordula princeps*, Hagen, and *Neurocordula obsoleta* Say, a brilliant scarlet one *Sympetrum rubicundulum* Say, and the bluish green *Gomphus externus* Hagen. The nymphs of these species are occasionally found as wanderers in the shallow waters immediately adjoining the sand bars, as well as those of the stone fly, *Pteronarcys dorsata* Say. Occasionally, also, one may find the larvæ of *Parnid* beetles, of Leptid flies such as *Atherix* and the cases of caddis worms such as *Hydropsyche* sp. It seems that few adult aquatic insects haunt sand bars from which the water weeds are absent, and the condition affecting the occurrence of their larvæ there, except where accidentally swept by the current from deeper portions of the river bed, is the presence or absence of the mud favoring the growth of the water weeds. The latter also harbor tadpoles and worms upon which the young of dragon flies and other water animals feed, as well as living and decaying animal and vegetable matter of various kinds much of which can be studied only with the use of a microscope. On the dry parts of the bars there are occasionally seen various grasshoppers, cabbage and monarch butterflies, as well as other insects which have not been identified. These, however, are all wanderers from the mainland, having been blown there by the air currents. Generally speaking, the insect life associated with the sand bars is not at all well known.

Crayfish are often seen wandering around the shallow water adjoining the bars and seem to become most numerous after nightfall. They are highly mobile animals whose scavenger propensities are satisfied by any carrion which may have drifted there. The species which have been collected there are *Cambarus* (*Faxonus*) *virilis* Hagen, and *Cambarus* (*blandingii*) *acutus* Gerard. They do not appear to be permanent inhabitants of the sand bars because few or no "castles," as the piles of mud above their burrows are termed, have been observed there. Where, however, mud has been precipitated on the sand bars, castles become more common for the creatures have suitable materials for making them.

By far the most characteristic animals inhabiting the mud and sand bars are the fresh water mussels whose food consists of microscopic animals and plants, or their remains, carried to them by the current. The mussels one sees there have undoubtedly had their origin in the beds of the deeper portions of the river. The same currents which scour the bottom of the river and deposit sediment on the bars, loosen these creatures from their close association with the other mussels, and they are carried off down stream, to be later deposited on the bars. This is especially true of the juvenile shells. Mussels are for the most part rather inactive, but the tracks they make as they slowly move back and forth in the shallow water bordering the sand bars are a very prominent feature of this region. It is probable that most of these creatures arrive there during periods of flood. The currents at such a time are unusually powerful, and large and heavy species of mussels, such as the pocket book, are known to be carried along by their velocity. As the water succeeding a flood period falls, the mussels are frequently left stranded and in response to the conditions of heat, the creatures burrow in the mud and die there. This is often revealed

by excavation of small depressions seen on the surface of the bar. Some may survive by slowly moving toward the more congenial living conditions of the deeper parts of the river bed, as the water falls, but many are unable to move fast enough. Species of *Najades* (Mussels) found in order of their abundance on these sand bars are the pocket book, (*Lampsilis ventricosa* Barnes); the pigtoe, (*Fusconaia undata* Barnes); the three ridge, (*Amblema peruviana* Lam.); the white heel splitter, (*Lasmigona complanta* Barnes); the paper shell, (*Leptodea fragilis* Raf.); the hickory nut, (*Obovaria olivaria* Raf.); the Lake Pepin mucket, (*Lampsilis siliquoidea* Barnes); the slop bucket, (*Anodonta corpulenta* Cooper); the pimple back, (*Quadrula pustulosa* Lea); the paper shell, (*Proptera laevissima* Lea); the slough sand shell, (*Lampsilis fallaciosa* Smith); and the three-horned warty back, (*Obliquaria reflexa* Raf.). The pigtoe, three ridge, and pimple back are among the more sluggish shells, moving about but little. They are thus more likely to be left high and dry by the retreating waters, while the Lampsiline shells being more active, have a better chance to get away. At least eight kinds of the mussels found on sandbars have a commercial value and they are among the most abundant on the sand bars after the floods. Associated with the mussels are other types of molluscan life. Frequently there appear specimens of the large river snail, *Campeloma subsolidum* Anthony, *Pleurocera acuta* Raf. and species of smaller ones represented by *Goniobasis* and *Planorbis*. *Sphaeridae*, which are bivalve molluscs sometimes mistaken for young clams, are often common in the vicinity of sand bars especially near the dams and are represented largely by *Sphaerium stamineum* Conrad.

Often these mollusks with many young game fish may also be found in great numbers in pools on the inner borders of the sand bars, especially those originating between dams. They have been left there by high water, and are unable to escape. A fish rescue crew of the U. S. Bureau of Fisheries was observed to remove nearly four hundred mussels of a commercial, marketable type from one of these pools nearly two hundred feet in length, ten to twelve feet wide, and about two and a half feet in depth. The same pool contained between two and three thousand game fish of a length not greater than five inches. Ordinarily, the resources of the Bureau of Fisheries permit the rescue of only the game fish, but good conservation practice indicates that these mussels should be rescued from their predicament and restored to the river where they can propagate. This is particularly important because this region of the upper Mississippi has exhibited an increasing scarcity of mussel life in the past few years, and most of the raw shells used in the manufacture of pearl buttons are produced in and about this region.

It is interesting to note that the most common shells found on the sand bars are also the most common ones in the sloughs, as the detached portions of the river channel are called. This is probably to be explained by the fact that they have been swept into the sloughs by the river currents when in a juvenile stage, and survive there because conditions keep them from migrating back to the river. Active shells, however, like the pink heel splitter (*Proptera alata* Say), are not common in the sloughs but at times appear common on the sand bars. While the order of the abundance of the shells is somewhat changed on the "made" bars between the dams, the species are largely the same with the

exception that the pink heel splitter is usually absent from them, while the squaw foot (*Strophitus edentulus* Say) appears on mud bars only. Occasionally there are also found on the "made bars" specimens of the yellow sand shell, (*Lampsilis anodontoides* Lea); the Higgin's eye ,(*Lampsilis higginsii* Lea); the sugar spoon (*Carunculina parva* Barnes); the river mucket, (*Actinonais carinata* Barnes); the deer toe, (*Amygdalonais truncata* Raf.); the long john, (*Eurynia recta* Lam.); the monkey face, (*Quadrula metanevra* Raf.); the sugar spoon, (*Amygdalonais donaciformis* Lea); the slop bucket, (*Anodonta corpulenta* Cooper); and the paper shell, (*Anodonta imbecillis* Say). Often a large number of mussels will be found in mud pockets close to the wing dams.

As one leaves the water edge of the sand bar he frequently notes large numbers of dead mussel shells lying scattered about. These comprise the shells previously listed and in many cases species which have largely disappeared from the adjoining river. Among these dead shells have been noted the valuable niggerhead shells, *Fusconaia ebenus* Lea, and *Pleurobema catillus* Conr., and in fact almost any of the sixty-three species of shells which have been listed from the upper Mississippi. These shells have died either as a result of low water, or have been killed by pearl hunters or muskrats. A section through a sand bar will often show the shells in successive layers. Gradually the effects of the sun and the solvent action of water cause a disintegration of them and the minerals they contain go to enrich the sand of the bars, making it more hospitable to the plant life which will eventually come in greater profusion.

The vertebrate life in association with the sand bars is highly developed. Most of the fish in the river follow the edge of the sand bars at some time or other in search of food. The fish bring more of the other animals and birds to these places than anything else does, as they are preyed upon by all the flesh-eating animals and birds. The smaller fish and minnows which feed on insects along the shores also seek the shallow waters of the bars for safety and protection against the larger fish that prey on them.

Among the fish most frequently inhabiting the edge of the bars for protection are the minnow, (*Notropis atherinoides* Raf.) and all the small and young fish of the following kinds—viz., the carp, (*Cyprinus carpio* L.); the buffalo (*Ictiobus cyprinella* Cuv. and Val.); the sucker, (*Catostomus commersoni* Lacepede); the sheepshead, (*Aplodinotus grunniens* Raf.); the moon-eye, (*Hiodon alosoides* Raf.), the garpike, (*Lepidosteus osseus* L.); the pike, (*Esox lucius* L.), the large and the small mouthed black bass, (*Micropterus salmoides* Lac.), the perch, (*Perca flavescens* Mitchill), the crappie, (*Poxomis annularis* Raf.), the skipjack, (*Pomolobus chrysochloris* Raf.), the sun fishes, (*Lepomis pallidus* Mitchill and *Lepomis gibbosus* L.); the gizzard shad, *Dorosoma cepedianum* Le Sueur and various cat-fish, such as the channel cat, (*Ictalurus punctatus* Raf.), the bullhead, (*Ameiurus nebulosus* Le Sueur), and the mud cat (*Leptops olivaris* Raf.).

These smaller and younger fish are followed by larger ones even of their own kind which prey upon them. Included here are the mud cat-fish, the channel cat-fish, the rock sturgeon, (*Acipenser rubicundus* Le Sueur), the sand sturgeon, (*Scaphirhynchus platorhynchus* Raf.), the garpikes, the pickerels, the wall-eyed pike, (*Stizostedium vitrium* Mitchill), the muskellunge, (*Esox

masquinongy Mitchill), the black basses, the white striped bass, (*Roccus chrysops* Raf.), the rock bass, (*Amblopites rupestris* Raf.), the perch, the crappies, the dog fishes, the skipjacks, and the moon-eyes, and in fact almost any of the fish. The sauger especially, (*Stizostedium canadense* Smith), and the walled-eyed pike may be expected on the edge of the bars at night, attracted by the abundance of food occurring at that time. Some of the other fish that pass by or lie in the deep water just under the reef are the carp, the buffalo, the white carp, (*Carpiodes thompsoni* Agassiz), the sucker, the sheepshead, the sunfish, the chub, the spoon-billed cat-fish, (*Polyodon spathula* Walbaum), the pike, the shovel nosed sturgeon, and the crappies. Plant life is thought to constitute most of the food for these fishes, although some like the carp are scavengers. Therefore the larger ones are not found in great numbers on the shallow bars but are more numerous in the ponds and sloughs. Sometimes the fresh water lamprey, (*Icthiomyzon concolor* Kirtland) is found among the larger fish of the vicinity of the sand bar, several attaching themselves to a fish weighing from seven to ten pounds and eventually killing him. Small numbers of all the fish that feed on plant life come to the shallow places to spawn if the water is dead, but the sloughs and ponds are usually a more suitable place. On that account large numbers may work back into these places. The spawning season usually begins about the middle of May, but it depends largely upon the temperature of the water. If it is too cold the spawning season will come later. Some of the game fish such as the pickerel and the pike spawn much earlier, even while the sloughs and ponds are still frozen over.

Of the Amphibia frequenting the vicinity of the sand bars the mud puppy, (*Necturus maculatus* Raf.) inhabits the deep water in the vicinity of the reefs, or the shallow water on bars where there is an abundance of muck. Here they frequently rob set lines and consume as great variety of living and dead food as they can swallow. They are often, and mistakenly so, considered poisonous. Occasionally, the newt, (*Triturus viridescens* Raf.) is seen swimming in the water on the edge of those bars on which aquatic vegetation has developed and also the pickerel frog, (*Rana pipiens* Schreber), the bull frog, (*Rana catesbiana* Shaw). These all feed on the life associated with the water-plants. Where dry portions of the bars adjoin moister regions covered with vegetation, is found the toad, (*Bufo americanus* Le Conte). The frogs often fall victims to larger members of their kind and with newts constitute a food for larger species of fishes, birds and mammals haunting the vicinity of the sand bar. The toads consume such insects as come their way.

The higher sand bars make an ideal hatching ground for the turtles. The snapping turtle, (*Cheleydra serpentina* L.), the soft shell turtle, (*Trionyx spinifer* Lesson) and the western painted turtle (*Chrysemys marginata* Agassiz) all come out on the bars to deposit their eggs a few inches under the surface, there to be hatched out by the sun. The eggs attract birds and mammals, which rob the nests for their food. During the summer turtles and tarrapins may be seen in small groups on the edge of the bar, quickly taking to the water at the approach of a boat. Among the other reptiles, snakes are represented by occasional specimens of the water snake, (*Tropidonotus fasciatus* var. *sipedon* L.)—often called the water moccasin, but non-poisonous. They

are seen mostly during the warmer months in the shallow water adjoining the sand bar and occur most frequently where vegetation has taken hold. Professor J. M. Holzinger relates that in the shallow water of Beef Slough he observed one of these creatures with her numerous progeny hunting minnows. The young moved back and forth repeatedly upon a school of them with great rapidity, causing scores to leap out of the water to escape their relentless pursuers. Later, the old snake was observed swimming leisurely near the bank surrounded by her brood. Other snakes which find a living on or near the vicinity of the sandbars are the bull snake, (*Pituophis sayi* Schlegel) and the blue racer, (*Zamenis constrictor* var. *flaviventris* Say). Both of these feed in part on the smaller mammals venturing into the region. The garter snake, (*Eutaenia sirtalis* L.) and the blow adder, (*Heterodon platyrrhinus* Latreille) are often attracted by the presence of the toad. There remains to be mentioned among the reptiles seen on the sandbars, one of the pigmy rattlesnakes, the massasauga, (*Sistrurus catenatus* Raf.) whose diet is principally frogs.

The older and more permanent the bar, the more vegetation and protection, and therefore more bird and mammalian life, will exist there. At some time or other all of the birds in this region of the Upper Mississippi, over 300 different kinds, follow the water in search of food. The most common inhabitants of the sand and mud bars are the waders such as the sandhill crane (*Grus Mexicana* Müll.), the great blue heron (*Ardea herodias herodias* L.), the green heron (*Butorides virescens virescens* L.), the horned grebe (*Colymbus auritus* L.), the American bittern (*Botaurus lentiginosus* Montag.), the east bittern (*Ixobrychus exilis* Gmel.), Cory's bittern (*Ixobrychus neoxanus* Ord.), Wilson's snipe (*Gallinago delicata* Ord.), and the golden plover (*Charadrius dominicus dominicus* Müll.). Their food consists chiefly of small fish and minnows, snails, small frogs, etc.

Many swimming birds haunt the vicinity of the sand bars. These comprise at various seasons the loon (*Gavia immer* Brunn); the red-throated loon (*Gavia stellata* Pont), the herring gull (*Larus argentatus* Pont), Franklin's gull (*Larus franklini* Rich), the Caspian tern (*Sterna caspia* Pallas), the coot (*Fulica americana* Gmel.), the brant (*Branta bernicla glaucogastra* Brehm), the pelican *Pelicanus erythrorhynchus* Gmel.), and the swan (*Olor columbianus* Ord.). The ducks are at one time or another present in greater variety than any other form of bird life. Among the migratory or winter species are the red-breasted merganser (*Merganser serrator* L.), the baldpate (*Anas americana* Gmel.), the red head (*Aythya americana* Eyton), the canvas back (*Aythya vallisneria* Wilson), the American Golden Eye (*Glaucionetta clangula americana* Bonap.), Barrow's Golden Eye (*Glaucionetta islands* Gmelin), the buffle head (*Charionetta albeola* L.), the old squaw (*Clangula hyemalis* L.), the American Scoter (*Oedemia americana* Swainson and Richardson), the lesser snow goose (*Chen hyperborea* Pallas), the Canada goose (*Branta canadensis* L.), and the trumpeter swan, (*Olor buccinator* Richardson). Other members of the duck tribe which have been observed on the sand bars are the American merganser (*Merganser americanus* Cassin), the hooded merganser (*Lophodytes cucullatus* L.), the mallard (*Anas Boshas* L.), the black duck (*Anas obscura* L.), the Gadwall (*Anas strepera* L.), the green winged teal (*Nettion carolinense* Gmelin), the blue

winged teal (*Anas discors* L.), the shoveller (*Spatula clypeata* L.) the pintail (*Dafila acuta* L.), the wood duck (*Aix sponsa* L.), the lesser Scaup (*Aythya affinis*, Eyton), and the ruddy duck (*Erismatura rubida* Wilson).

Often one may also see the kingfisher (*Ceryle alcyon* L.) the crow (*Corvus brachyrhynchus brachyrhynchus* Brehm); the yellow headed black bird (*Xanthocephalus xanthocephalus* Bon), and the osprey (*Pandion haliaetus carolinensis* Gmel.). Now and then in the higher and more heavily vegetated bars will be observed the grouse (*Bonasa umbellus umbellus* L.), an occasional quail (*Colinus virginianus virginianus* L.), the chipping sparrow (*Spigella passerina passerina* Bach), the vesper sparrow (*Pooecetes gramineus gramineus* Gmel.), the song sparrow (*Melospira melodia melodia* Wils.), the white throated sparrow (*Zonitrichia albicollis* Gmel.), the cliff swallow (*Petrochelidon lunifrons lunifrons* Say), the barn swallow (*Hirundo erythrogaster* Bood), the bank swallow (*Riparia riparia* L.), the greater yellow legs (*Totanus melanoleucus* Gmel.) the lesser yellow legs (*Totanus flavipes* Gmel.), the long-billed curlew (*Numenius americanus* Wils.) the kildeer (*Oxyechus vociferus vociferus* Lam.), the wood cock (*Philohela minor* Gmel.), the Wilson Phalarope (*Steganopus tricolor* Vieill), while rapidly running along at the water's edge may be seen the white rumped sandpiper, (*Pisobia fuscicollis* Vieill).

The migrating birds, especially the more wary ones, such as the geese, the swans, and the ducks, stop on the open bars for protection while they rest. It is impossible for the hunter or their natural enemies to get near them while resting on such places. Here they obtain also food and gravel. Many of the wading birds feed at night, but some, such as the kingfisher, the blue heron and all of the ducks and geese, do their fishing and feeding during the day.

Not many birds or mammals make their permanent homes on the sand bars for a variety of reasons. Usually, the bars are low and the burrowing animals can not dig down deep enough before they strike water. Even before striking water the soil would be too wet for most of them to choose for a den in which to bring up their young. Then as a rule the timber is not very heavy on these low places, the main growth being willows which do not afford good shelter for permanent homes for the raccoon, woodchuck, etc., and for the larger birds. Usually when any of the animals have made their home on one of these places, it is in a stump log or drift pile which was brought there in flood time. Nevertheless, almost all of the mammals and birds of the region visit them frequently in search of food, and the migratory birds come there to rest.

Not so many years ago one might have seen on the sand bars, where they came to drink or feed, signs of the black bear (*Ursus americanus* Pallas), the beaver (*Castor canadensis* Kuhl), the lynx (*Lynx ruffus* Guldenstadt), the wolverine (*Gulo Luscus* L.), the otter (*Lutra canadensis* Schreber), the fisher (*Mustela americana* Turten). But the increasing clearings for farms have taken away their natural protection and they have had to move on or be taken by the trapper. At present, an occasional deer (*Cervus virginianus* Bodd) is seen, but the remainder are practically exterminated along the region of the Mississippi with which we are dealing.

The mammals more frequently inhabiting the region of the sandbars are the raccoon (*Procyon lotor* L.), the mink (*Putorius visor* Schreber) and the muskrat

(*Fiber zibethecus* L.). They come to the bars to catch fish, minnows, and mussels. They are swimmers and visit bars that are entirely surrounded by water as well as those that are connected to the main shore or higher land. Most animals can not open the mussels, but the muskrat can open all of them. The smaller ones yield to his teeth and paws but for the larger ones, which are too strong for these, a different procedure is followed.* They are carried out and piled up on the banks—sometimes as many as 15 or 20—where they are left to die, when the shell opens. The animal comes back to feed off his supply as he brings more out in the same way. These piles of clams attract other animals which rob him of his food. The muskrat does the same thing in winter, except that the clams are stored under hollow ice where they die in about three days. Thus in the spring of the year a great many shells that have been brought out in this manner are found along the water's edge. They do not all go to waste as the clammer may later pick up the shells which have a market value and sell them.

Other mammals search for food on the bars connected to higher land, but do not swim out to those surrounded by water. Such are occasional timber wolves (*Canis nubilis* Say), the coyote (*Canis latrans* Say), the red fox (*Vulpes fulva* Desmarest), the wood or gray fox (*Urocyon cinereo-argenteo* Schreber), the skunk (*Mephitis hudsonica* Richardson), the spotted skunk (*Spilogale interrupta* Raf.) and the weasel (*Putorius noveboracensis* Em.). The food they pick up consists mostly of dead fish, mussels, frogs, mice or the birds and other mammals they may catch. On an older bar upon which the willows and other vegetation are encroaching there may be found rabbits (*Lepus americanus* Erxleben)—the varying hare, and the jack-rabbit (*Lepus campestris* Bachmann), cotton tails (*Sylvilagus floridanus mearnsii* Allen) and various species of the mouse family, such as the white-footed deer mouse (*Peromyscus leucopus noveboracensis* Fischer) and the common meadow mice (*Microtus pennsylvanicus* Ord.).

The preceding describes life on the sandbars as it is when the water is open. After the ice sets in, the fish take to deeper and warmer water, and the animals seek more shelter. A few of the animals and birds, such as the wolf, the fox, and owls, pass over these places at all times in their search for food, but in the winter all is bare, and no sign of life exists. The refuse and remains of the various animals inhabiting the sandbars at one time or another contribute valuable substances which increase the fertility of the harsh soil. As we have previously seen, the bar becomes more and more elevated above the surface of the water as time goes on. All the changes forecast the period when the bar will become firmly a part of the adjoining shore, and when a higher development of vegetation will make possible less transient types of animal life. But that is another story!

* For this and many other observations embodied in this article the authors are indebted to Mr. John Schmoker, veteran outdoor man of Fountain City, Wisconsin.

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ANNOUNCEMENTS

THE spring courses of Lectures and Museum Talks began as scheduled with satisfactory attendance.

The Regular Lectures are as follows:

Monday at 8 P.M. Professor Schmucker. *The Principles of Animal Life.* Twelve lectures, ending April 2 (Feb. 13 omitted on account of holiday).

Tuesday at 8 P.M. Professor Howell. *Physical Geography. The Earth and its Inhabitants as we find them today.* Sixteen lectures ending April 17.

Wednesday at 8 P.M. Professor Seely. *Heat and Sound.* Sixteen lectures, ending April 25 (Feb. 22 omitted on account of holiday).

Extra lectures on special subjects will be announced as arranged. A syllabus of the Westbrook course for 1928 is given on the next page.

For information concerning any of the activities of the Institute application should be made to the office.

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FOUR LECTURES ON THE SCIENCE OF MUSICAL SOUNDS

By DAYTON C. MILLER, D.Sc.
Professor of Physics, Case School of Applied Science, Cleveland, Ohio.

Fridays and Saturdays, March 9, 10, 16, 17. At 8 P.M.

1. Friday, March 9. SOUND WAVES AND METHODS FOR RECORDING AND PHOTOGRAPHING THEM. Characteristics of Tones: Pitch, Intensity, and Tone Color. Simple Harmonic Motion. Analysis and Synthesis of Harmonic Curves. Influence of Horn and Diaphragm on Sound Waves.

2. Saturday, March 10. ACOUSTICS OF AUDITORIUMS. Processes of Hearing Speech and Music. Control of Acoustic Properties and Design in Advance of Construction. Noises and Non-Musical Sounds. Sounds of Bells, Fog Horns, Large Guns, and Projectiles. Normal Velocity of Sound.

3. Friday, March 16. TONE QUALITIES OF MUSICAL INSTRUMENTS. Resonance. Beat-tones. Identification of Instrumental Tones. The Ideal Musical Tone. Characteristics of Orchestral Instruments.

4. Saturday, March 17. PHYSICAL CHARACTERISTICS OF THE SOUNDS OF SPEECH. Theory of Vowel Quality. Standard Vowels. Artificial and Synthetic Vowels. Word Formation. Vocal and Instrumental Tones. The Relations of the Art and Science of Music.

The lectures will be illustrated with experiments and slides.
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THE DUODECIMAL SYSTEM—A SPECULATIVE ESSAY

HENRY LEFFMANN

If the human animal had six fingers on each hand arithmetic would be simpler than it is. A system in which twice six is ten would give a base divisible without fractions by 2, 3, 4, and 6, while the present system is so divisible only by 2 and 5. It comes, of course, as a shock to most persons to make such a serious change in ratios. The great mass of the community hold the view that our calendars, number-ratios, time-divisions, and similar fundamentals have a sort of sacred sanction. Some years ago, when war pressure forced the adoption of the daylight-saving, a woman wrote to a Philadelphia newspaper complaining about trifling with "God's time." The editor published the letter without even calling the writer's attention to the fact that the established standards are as arbitrary and artificial as the proposed modification. Many opponents of reformed spelling cry out against "disturbing the spelling of Shakespere and Milton," not knowing anything about the original texts of these writers. Shakespere, for instance, spelled "politic" and "music" with a final "k." Our Revolutionary forefathers always spoke of "foederal" government.

Suggestions for the establishment of a duodecimal system have often been made. Charles XII of Sweden was at one time considering establishing it in his kingdom. Humboldt said that it is astonishing that no civilized nation has adopted it. Herbert Spencer, who was bitterly opposed to the introduction of the metric system into the British Empire, and left a sum of money as an endowment for counter propaganda in case any effort towards such adoption started, looked with considerable favor on a duodecimal system, and seemed to be inclined to the establishment of it by law, although so very positive in his opposition to the legalization of the metric system.

Several systems of numbers have been suggested. An "octet" is one of them, that is, twice four would be ten. This has no particular advantage and gives a rapid increase in numbers as the multiplication proceeds. Many years ago, a Philadelphia engineer, John H. Nystrom, proposed a system with sixteen units. He called it the "Tonal System," and wrote a book in advocacy of it. His principal claim was that the base is a fourth power and therefore yields many different factorings. He placed six new characters between 9 and 10. The plan is cumbersome and attracted little attention.

In connection with the suggestion for a duodecimal basis it has been pointed out that division into twelve parts is very frequent and popular. The division of the foot into twelve inches is an example. The dozen and the gross are extensively used units for merchandizing. A firm doing a large business in scientific apparatus and supplies makes the following statement in its catalog: "We favor the use of the metric system wherever practicable, but find many difficulties in the way of its rapid absorption . . . because of many items which pack better by dozens than by tens. For example, certain articles pack in a carton of satisfactory shape in three rows of four, rather than in one row of ten or two rows of five." Such practices will probably continue even if the metric system should be adopted by English-speaking peoples. The inch is divided into twelve lines and the line into twelve points. The year has twelve months, the degrees of time and arc on a duodecimal basis as well as decimal. The day is universally on the twelve basis and no one would desire a change. Depths—in fathoms—and distances—in leagues—are also examples. Britain has a partial duodecimal currency; the shilling is twelve pence and the convenient two, three, four, and six pence will not be willingly surrendered. Mr. Eastman's newly proposed year of thirteen months will be impossible of satisfactory division as thirteen is a prime number.

Discussion of such a reform can only be academic; there is no hope of its general adoption. It is, however, permissible to speculate on the value of the change and to set forth a plan. It will necessitate the introduction of two new units with suitable signs and names. They are best placed between the 9 and 10 as this will leave the ratios between 1 and 9 mostly undisturbed. In conversation with Mr. L. E. Picolet of the Franklin Institute, he suggested that the zero should be included which would permit of obtaining a series of 12 with addition of only one new character. There seems, however, to be here a disturbance of the relation of the lower figures and the subject can not be properly discussed at present. The mention of the zero leads to an allusion to the origin of our customary system. It is generally termed "Arabic" but it is regarded by most historians as originating in India. It has two outstanding features that give it enormous value over all other methods of expressing numbers. It contains the zero and it distinguishes the successive powers of ten by the position of the figures 1, 10, 100 and so on. If one compares the simplicity of such an operation as dividing 45 by 15 with the Roman method XLV by XV, the vast advantage of the Hindu numerals will be seen. Awkward methods were in vogue with other ancient nations and some have been carried down into modern

times. Thus the Hebrew expression for the current Jewish year (5688) is by the letters HTRPCh. H is 5, T 400, R 200 P 80 and Ch (which is a guttural consonant corresponding to the German ch, not existing in English) 8. The Hebrew alphabet has only 22 letters (they are all consonants; the vowels are usually understood) and the counting is by assigning to the first ten letters the figures from 1 to 10, then follow in order 20, 30, 40, 50, 60, 70, 80, 90, 100. Only three letters remain and these, R, S, T, are respectively 200, 300, and 400. Hence in making 600 a combination of T and R is used. Arbitrarily, also the letter H for 5 is used by position for 5000.

As noted above two new signs and two new names will be needed. These must conform to certain conditions in order to avoid confusion and make the change as easy and simple as possible. As regards signs, these must be different from each other and from all other number signs; they must be made with a single stroke and should be obtainable by simple adaptation of signs already in use in well-supplied printing offices. The names must be new coinage, monosyllables, and of such form as to ensure that all English-speaking persons will pronounce them about the same, and they should contain no letter which will be difficult to the more important foreign nations, and not having markedly different sounds in these languages. The names must also join euphoniously with "ty" and "teen."

Giving the subject thought and bearing in mind the above conditions the signs and names have been devised as follows:

An inverted J and the name "kal."
An inverted V " " " "gan."

For convenience and to avoid costly typesetting these will be represented in this essay by K and G respectively, but they should be read "kal" and "gan" and not as letters.

The first decade of numbers would then run as follows in comparison with the decimal system:

									kal	gan	
1	2	3	4	5	6	7	8	9	K	G	10
1	2	3	4	5	6	7	8	9	10	11	12

Multiplication will not be different below 5, but

5 x 2 = K	6 x 2 = 10	7 x 2 = 12
8 x 2 = 14	9 x 2 = 16	K x 2 = 18
G x 2 = 1K (kalteen)	10 x 2 = 20	

Passing to the latter part of the 100 series we will have as illustrations the following:

	ninety kal	ninety gan	kalty		
90 to 99	9K	9G	KO		
through	kalty one to	kalty nine	kalty kal	kalty gan	ganty
	K1	K9	KK	KG	GO
ganty will run to	ganty kal	ganty gan			
	GK	GG	100		

Conversion of one system into the other is based on simple principles. For numbers below 10,000, tables will be most convenient, but calculations can easily be made. A few examples will be given and it will not be necessary to pursue the subject further.

Conversion of decimal into duodecimal quantities. Continuous division by 12, the remainders being the duodecimal figures, bearing in mind that a remainder of 10 is to be written as K and one of 11 as G.

Conversion of duodecimal into decimal: The right hand figure is not changed, but K must be written as 10 and G as 11. As one goes to the left the powers of the base increase and the numbers must be multiplied by 12, 144, 1728 and so forth.

Examples

Convert 1728 decimal into duodecimal

12 |1728	0		12 |1727	11
12 |144	0		12 |143	11
12 |12	0			11
1				

1728 decimal equals 1000 duodecimal. 1727 = GGG

Convert 1148 duodecimal into decimal 3K and 4G into decimal

8	equals	8	K = 10
40	"	48	30 = 36
100	"	144	46
1000	"	1728	
		1928	G = 11
			40 = 48
			59

Convert G4K7 to decimal

7	equals	7
K	"	120
4	"	576 (144 x 4)
G	"	19008 (1728 x 11)
		19711

Suggestion for changes in number basis have often been coupled with suggestions for new signs and new names for all figures, but this does not seem necessary. The new system can be easily distinguished from the standard. Thus 135, one thirty five, will be on the decimal system, *135, *one thirty five, would be duodecimal.

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ANNOUNCEMENTS

THE spring courses of lectures comprising Zoology, Physics and Geology were completed according to schedule, with a markedly larger attendance than in former years. The Museum talks have also been fully carried out with encouraging interest on the part of students.

The Westbrook lecture course for 1928, by Dr. Dayton C. Miller, of Cleveland, Ohio, on "The Science of Musical Sounds," attracted large and interested audiences, and was a valuable contribution to applied acoustics. Among the illustrations was the Phonodeik, an instrument devised by Dr. Miller to show on the screen the vibration of musical sounds. Special lectures have been given as follows:

"The Broad Street Subway." Charles H. Stevens.

"The Yellowstone National Park." Professor Samuel T. Wagner.

"Inland Waterways." Hon. J. Hampton Moore.

The Closing Exercises of the session of 1927–8 will be held at the Hall of the Institute on Wednesday evening, May 9, 1928. Detailed notice of this will be given later.

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In Memoriam

JOHN GOODHART ROTHERMEL

December 3, 1847 — *April 1, 1928*

John Goodhart Rothermel, for many years Director of the Wagner Free Institute of Science, was born in Philadelphia. His father, Peter Frederick Rothermel, was a distinguished American artist and was chosen by the Pennsylvania authorities to paint the memorial picture of the battle of Gettysburg, now in the Capitol at Harrisburg.

Mr. Rothermel was educated at the Huilier Academy in Paris and under private tutors in Italy and Germany. Returning to the United States, he took courses in engineering and was at one time member of a construction corps on the railroad near Wilkes-Barre, Pa. He also took a course in bookkeeping at a well-known Philadelphia Business College. In early adult life he was in business, but in 1894 he became connected with the *Philadelphia Times*, and in 1896 took charge of the scientific features of the paper, in which duty he continued until 1902.

He assumed charge of the Wagner Free Institute of Science in 1903. At that time the endowment of the Institute was largely in residential real estate, and Mr. Rothermel began at once to establish complete control of all the business affairs, carrying out the several phases with scrupulous integrity and meticulous attention to details. He promptly devoted himself to the scientific activities of the Institute, especially to the museum, which was largely rearranged under his supervision and many valuable specimens added through excursions. Among these additions is a fine, and in some respects unique, collection from the petrified forests of Arizona.

His scientific studies were principally in anthropology and geology, but he had an active interest in the lower forms of animal life and was an expert microscopist.

His duties as Director of the Institute continued until 1924, when his health failed so seriously that he was obliged to relinquish all activities. He was retired upon a pension. His valued services during a long and active life gained for him a host of friends and acquaintances who esteemed him highly, appreciating fully his devotion to the accumulation and communication of knowledge, courtesy and readiness to assist all who desired information on subjects with which he was acquainted.

The writer of this memorial was elected a Trustee of the Institute in 1903, and soon thereafter was appointed Chairman of the Committee on Finance and Property. For over a score of years he was in constant relation to the business administration of the Institute and wishes to bear witness to the enthusiastic devotion with which Mr. Rothermel discharged the duties imposed on him, with skill and scrupulous honesty in every detail.

MOSS DISTRIBUTION IN THE EASTERN UNITED STATES

By George B. Kaiser
Professor of Botany, Wagner Free Institute of Science

The true mosses are flowerless spore-bearing plants of the class Musci, a member of the group Bryophyta. Over the whole earth they number considerably more than seventeen thousand species and the number is still being increased by descriptions. They are found in water, on soil and rock, living or dead trunks of trees, and occasionally in animal excrement. The eastern United States, with its swamps, lakes and streams, its Appalachian range forming a kind of spine from north to south, in part thickly wooded and ascending to Alpine heights in New England, the fertile hills, valleys and plains extending east and west of the Alleghenies, and the Coastal Plain ending in pure sand at the Atlantic shore, possesses a rich and varied flora. The distribution of the mosses in this region has been determined by careful collection and subsequent study of the material.

As curator of the Moss Herbarium of the Sullivant Moss Society for almost a score of years, the author has determined thousands of specimens in the collections of others as well as his own, specimens obtained in the eastern United States, and it is upon the data thus acquired that the following notes are founded.

The class Musci is divided into three orders: Sphagnales, Andreæales and Bryales.

The Sphagnums, or peat-mosses, with thirty-seven species growing in the eastern United States, according to A. LeRoy Andrews, are confined to water or very wet soil. The species, as now classified, are difficult to determine, being based upon the arrangement of the cells in the cortical layers of the stems and branches and upon the microscopic structure of the chlorophyll-bearing cells in the leaves. The forms are many and variable, as is often the case with aquatic species. The uninitiated may differentiate the old forms, *S. acutifolium* Ehrh., *S. cymbifolium* (Ehrh.) Hedw., *S. squarrosium* Pers., *S. macrophyllum* Bernh. and a few others, but on account of its complexity the order is one of particular scientific interest only to the expert sphagnologist. The Andreæales contain within our range only three species. These are mosses, dark or golden brown, growing in ample mats on rocky ledges in the mountains with tiny sporophytes whose capsules dehisce by four valves, opening slits through which at maturity the spores are discharged. *Andreæa petrophila* Ehrh. abounds in some of the higher peaks of New England, where also occur *A. rupestris* (L) Hedw. and the closely allied *A. crassinerva* Bruch. The first two species are also found in the Catskill and Shawangunk Mountains of New York and southward to Virginia and Alabama.

The remaining Bryales contain all our other mosses and show most interesting developments of both gametophyte and sporophyte,

ranging from very primitive forms to those highly developed and often exceedingly beautiful species which adorn the rich woods of our mountainous regions.

Lowly forms of the Acrocarpi, terminal fruited mosses, in the Bryales, are found in various families. They consist of dwarf plants which bear immersed or only slightly emergent capsules. These when ripe dehisce irregularly or break open along a well-defined divisional line. They are tiny mosses occurring often in fallow fields, on clay or sandy soil, rarely on bark, and are to be studied closely only by falling to all fours and freely using the hand lens. In this catalog are *Pleuridium subulatum* (L) Rabenh., *Bruchia Sullivantii* Aust., *Acaulon rufuscens* Jacq., *Astomum Sullivantii* Schimp., *Phascum cuspidatum* (L) Schreb., *Aphanoregma serratum* Sulliv., and the still smaller members of the Ephemeraceæ, of which *Nanomitrium synoicum* Schimp., new to this country, was found by the author abounding on the dikes of Raccoon Creek, near Swedesboro, New Jersey. The collection of these extremely small plants has a peculiar fascination for those who once engage in it.

In higher forms of the Musci the sporophyte has considerably developed. It is borne on a stalk or seta and the teeth around the mouth of the capsule which form the peristome, single or double, are much differentiated and under the microscope are often objects of great beauty in structure and coloration. The Acrocarpi include in our flora a number of well-marked families with many species of wide distribution. Polytrichaceæ show leaves furnished with lamellæ to give greater absorption surface and a peristome with an epiphragm, a circular disc raised and lowered in alternations of dryness and moisture, thus aiding in the spreading of the spores. *Polytrichum perigoniale* Schimp. occurs abundantly in open fields and swamps and often preempts the ground to the detriment of good pasture. In the woods *P. ohioense* R. & C. is the common species, while in sandy soil or on ledges or banks *P. juniperinum* Willd., of a glaucous green color, is plentiful, grading to *P. piliferum* Schreb., whose leaves end in a rough fine point under sandier or arid conditions. Toward Alpine regions, *P. strictum* Banks shows stems matted with tomentum and sporophytes considerably dwarfed. The closely allied genus *Pogonatum* is represented by the species *P. brevicaule* (Brid.) Beauv., with a conspicuous protonema found on bare clay banks in the lowlands; widely distributed in the mountains are *P. alpinum* (L) Roehl., *P. capillare* (Mx) Brid., and *P. urnigerum* (L) Beauv.

The folding of the leaf in the Fissidentaceæ is an ear-mark of that family, of which we have six or seven species. *F. adiantoides* Hedw. is the largest, found in the mountains, and the tiniest and daintiest is *F. miniutulus* Anst., for which we may look on damp stones in both high and low regions. Fairly abundant also are the intermediate species, *F. osmundioides* Hedw., *F. taxifolius* (L) Hedw., and *F. sabbasilaris* Hedw.

Dicranaceæ show a split single peristome and secund or crispate leaves, *D. scoparium* (L) Hedw. being the commonest and *D. majus*

Turn., found only from Maine easterly—the largest and most beautiful species of the genus Dicranum. Among other abundant species may be mentioned *D. flagellare* Hedw., *D. fuscescens* Turn., *D. fulvum* Hook., *D. montanum* Hedw., *D. spurium* Hedw., and in pure sands near the coast *D. pallidum* B. & S. In mountain regions *D. undulatum* Ehrh., and *D. drummondii* Muell. are very fine mosses. To this family belong the cosmopolitan *Ceratodon purpureus* (L) Brid., *Dicranella heteromalla* (L) Schimp., *Ditrichum tortile* (Schrad.) Hampe, *D. pallidum* (Schreb.) Hampe and many other forms which space forbids mentioning.

Leucobryum glaucum (L) Schimp., the white moss, which may be seen in pincushion-like mats in many of our moist woods, is the sole representative of the family Leucobryaceæ until we get down to Florida, where *Octoblepharum albidum* (L) Hedw. is found on the decaying trunks of palmettos. *Leucobryum* is reproduced vegetatively by the germination of broken leaves and seldom fruits. In the cushioned mosses of the Grimmiaceæ, *Grimmia apocarpia* (L) Hedw. is our commonest species, with small immersed sporophytes whose capsules show peristomes resembling tiny starfish, while *G. pennsylvanica* Schwaeg. and *G. olneyi* Sulliv., are also frequent in our eastern states. In the mountains of New England, *G. doniana* Smith is of rather rare occurrence. *Rhacomitrium* is another genus in this family with sinuose areolation in the leaves as an outstanding character. In hilly or mountainous country we may look for *R. aciculare* (L) Brid., *R. fasciculare* (Schrad.) Brid., *R. microcarpum* (Schrad.) Brid., and more rarely *R. sudeticum* (Funck) Brid. *Ptychomitrium incurvum* (Schwaeg.) Sulliv. is an attractive little moss of this family found on granite boulders.

In the Pottiaceæ or Tortulaceæ we find a number of limestone-loving mosses—for among the Bryophytes as well as in other groups plants may be distinctly calcicolous or calcifugous. In the former category are *Tortella tortuosa* (L) Limpr., *Barbula unguiculata* (Huds.) Hedw., *B. convoluta* Hedw., *Gymnostomum curvirostre* (Ehrh.) Hedw., and *G. calcareum* Nees and Hornsch. Here the family trait is a twisted peristome which is lacking in the genus *Gymnostomum*.

On trees and rocks we may find specimens of the chief genus of mosses in the Orthotrichaceæ, Orthotrichum, whose members are small in size, with slightly emergent capsules and single or double peristomes. We find *Orthotrichum sordidum* S. & L., *O. strangulatum* Beauv., *O. speciosum* Nees, *O. porteri* Aust. and *O. pusillum* Mitt. to be the most frequent species in our region, while *Ulota americana* (Beauv.) Lindb. on rocks, and *U. crispa* Brid. and *U. ludwigii* Brid. on living trees, are of more frequent occurrence in the same family.

Of the acrocarpous families, Aulacommiaceæ includes *Aulacommium palustre* Schwaeg. of swamps, and *A. heterostichium* (Hedw.) B. & S. of moist shaded banks as common species. Bartramiaceæ—named after our noted early botanist, John Bartram—has in it *Bartramia pomiformis* (L) Hedw., *B. oederi* (Gunn) Swtz.,

the latter found on limestone. These mosses are most attractive, growing in clefts of rock and hilly country, exhibiting, when fresh, pretty peristomes.

The Funariaceæ has in it that common species *F. hygrometrica* (L.) Sibth. -a sole representative of the Schistostegaceæ, growing under overhanging rocks, the Luminous Moss, *Schistostega osmundacea* (Dicks) Mohr., whose protonema shows bright golden green from the effect of light, is frequently found in New Hampshire, Vermont and elsewhere, Dr. Rodney M. True having recently noted it within the reach of salt spray on Orr's Island, Maine.

Sphlachnum Ampullaceum L. and *Tetraplodon mnioides* (Sw.) B. & S. of the Splachnaceæ may be looked for on animal excrement in high mountain regions, and the curious *Buxbaumia aphylla* L. of the Buxbaumiaceæ on shaded banks, the author having for several years studied it in the Wissahickon region in Philadelphia.

Finally the Bryaceæ, comprising, among other genera, *Bryum*, of which *B. argenteum* L. and *B. caespiticium* L. may be found almost everywhere. *Rhodobryum*, with the particularly fine *R. roseum* (Weis.) Limpr., *Pohlia* with one of our commonest mosses of all, *P. nutans* (Schreb.) Lindb. and *Mnium* with the most abundant species, *M. cuspidatum* (L.) Leyss, *M. affine ciliare* Grev., *M. punctatum* L. and *M. hornum* L.

The Pleurocarpi remain, mosses whose sporophytes are lateral.

Hedwigia albicans (Wed.) Lindb. is the only representative here of the Hedwigiaceæ, a small family. It occurs quite commonly on rocks and is widely distributed. To the Fontinalaceæ belong the aquatic mosses, *Fontinalis dalecarlica* B. & S., *F. gigantea* Sulliv., *F. novæ angliæ* Sulliv. and *F. lescurii* Sulliv., which occur quite abundantly in the eastern United States. *Dichelyma capillacea* B. & S. is a frequent species also in the family. Climaciaceæ is represented by *Climacium americanum* Brid., *C. kindbergii* R. & C., and more rarely *C. dendroides* (L.) W. & M.

Leucodon brachypus Brid. and to the south *L. julaceus* (Hedw.) Sulliv. and *Forsstroemia trichomitria* (Hedw.) Lindb. grow well up on the trunks of living trees, representing the Leucodontaceæ and on the same substratum in the mountains *Neckera pennata* (L.) Hedw. of the Neckeraceæ, while the Entodonaceæ furnishes us several species of Entodon, with *Pylaisia schimperi* B. & S., *Platygyrum repens* (Brid.) B. & S., and other mosses.

Rare and especially interesting is *Anacamptodon splachnoides* (Froelich) Brid. of the Fabroniaceæ. It may be sought in clefts of living tree trunks. The Leskeaceæ include the genera *Leskea*, with *L. gracilescens* Hedw., *L. obscura* Hedw., and several less frequent species; *Anomodon* with *A. rostratus* (Hedw.) Schimp., that species of yellow-green color often forming an apron at the bases of our forest trees and occurring also on limestone, *A. attenuatus* (Schreb.) Hueb., a species of stream sides, *A. minor* (P. Beauv.) Fuern. on trees, as well as the slender *A. tristis* (Ces.) Sulliv., southern in its range; *Thuidium* with a number of species, the most common *T.*

delicatulum (L) Mitt., *Myurella careyana* Sulliv., another calcicolous moss, and *Thelia* with *T. asprella* (Schimp.) Sulliv., and *T. hirtella* (Hedw.) Sulliv., on tree trunks and *T. lescurii* Sulliv., on soil.

The greater number of species, however, in the Pleurocarpi, belong to the next two families. Brachythecaciæ are mosses growing on rock, soil and wood, particularly along or in our streams. *Brachythecium* is a large and important genus, which includes *B. rivulare* B. & S., occurring in rivulets, of bold green habit, and quite conspicuous in the mass, *B. plumosum* (Sw.) B. & S., one of the commonest species, growing just beside or almost in the water, *B. acutum* (Mitt.) Sulliv., which likes much moisture too, while *B. oxycladon* (Brid.) J. & S., and *B. salebrosum* (Hoffm.) B. & S., are commonly found on banks and boulders. *Eurhynchium* also has species living in and near the water as well as on shaded banks. *E. rusciforme* (Neck.) Milde is an aquatic form, *E. serrulatum* (Hedw.) Kindb. occurs on humus and soil, while on shaded soil many forms of *E. strigosum* (Hoffm.) B. & S., and *E. hians* (Hedw.) J. & S. are found. Now separated from *Eurhynchium* may be mentioned *Cirriphyllum boscii* (Schwaeg.) Grout, and *Bryhnia novæ-angliæ* (S. & L.) Grout. Both are common and of wide distribution.

Hypnaceæ is the last and largest family of all. Its species grow abundantly through our range, and although we have not space to enumerate many of them, our article would be incomplete without a fitting tribute to the attractiveness in our mountain forests of *Ptilium crista-castrensis* (L) deNot., *Hylocomium proliferum* (L) Lindb., *Rhytidiadelphus triquetrus* (L) Warnst., *Drepanocladus uncinatus* (Hedw.) Warnst., and the only species that has been retained in the old genus Hypnum, *H. schreberi* Willd.

Linger in the haunts of these denizens of the woods, and you may come to know that fulness of peace and satisfaction which arises in the contemplation of esthetic beauty, especially when that contemplation is blended with the mental gratification of becoming better acquainted with the Musci, their life histories and distribution in habitats, which are delightful tarrying places for both students and nature lovers.

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Montgomery Ave. and Seventeenth St., Philadelphia, Pa., U. S. A.

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BULLETIN

of the

WAGNER FREE INSTITUTE OF SCIENCE
OF PHILADELPHIA

PUBLISHED BY THE INSTITUTE

Edited by the Publication Committee

HENRY LEFFMANN — SAMUEL TOBIAS WAGNER

Vol. 3	Bi-Monthly	$1.00 per year
No. 3	June, 1928	Single numbers, 20 cents

ANNOUNCEMENTS

THE Scholastic Year of the Institute was closed on Wednesday Evening, May 9, 1928. The entire session has been very successful both as to general attendance and class enrolment.

On the occasion of the Closing Exercises, Dr. Samuel C. Schmucker, President of the Faculty, made a short address, after which the awards of full course and partial course certificates were announced.

Professor Emory R. Johnson, of the Wharton School of Finance and Economy of the University of Pennsylvania, delivered a lecture on "CHINA."

A list of the students receiving certificates will be found on the next page.

During the vacation period, important improvements will be made in the Reference Library.

Entered as second-class matter, September 10, 1926, at the Post Office, Philadelphia, Pa., under Act of August 24, 1912.

CERTIFICATES FOR SESSION OF 1927-28

FULL TERM CERTIFICATES AWARDED: Engineering, Charles H. Seidel.

Botany, Frank E. Draper, H. May Hunter, Milton K. Meyers.

Inorganic Chemistry, Abraham Josel.

Organic Chemistry, Milton K. Meyers.

Zoology, Milton K. Meyers.

1927-28 CERTIFICATES AWARDED: Engineering 1, George A. Achenbach, Robert B. Bowman, Frank E. Draper, Paul O. Emerich, Paul W. Gehris, Cedric Haring, Emanuel Hocking, Chauncey R. Kay, Monroe P. Lesher, Henry O. Lind, Wilfred R. Newton, Andrew Pataky, Charles H. Seidel, Lawrence H. Tobias.

Botany 1, Charles Collins, Frank E. Draper, William Gilbert, Jr., H. May Hunter, Florence McIlravey, Milton K. Meyers, Ralph W. Miller, Mrs. Thomas H. Peacock, Henry C. Savage.

Inorganic Chemistry 3, Frank E. Draper, William Gilbert, Jr., William Josephs, Abraham Josel, Milton K. Meyers, Harold Poole, Joseph Popel, Manuel Tubis.

Organic Chemistry 3, Walter F. Estlack, William Josephs, Milton K. Meyers, Manuel Tubis.

Zoology 4, Charles Collins, Walter F. Estlack, Edward H. Gillette, William D. S. Gillette, H. May Hunter, Mrs. Dorothy G. Lloyd, Milton K. Meyers, Ralph W. Miller, Hugh S. Roberts, Henry C. Savage.

Geology 1, Frank E. Draper, Edward H. Gillette, William D. S. Gillette, Katherine R. Guest, Emanuel Hocking, D. Brooke Johnson, Dorothy G. Lloyd, Milton K. Meyers, Harold Poole, Henry C. Savage, Carl H. Wolff.

Physics 2, Marguerite N. Dickey, Frank E. Draper, Paul W. Gehris, Edward H. Gillette, William Gillette, H. L. Grabosky, Clive A. Henninger, Chauncey R. Kay, Dorothy G. Lloyd.

Museum Talks, Charles Collins, Ralph W. Miller, Hugh S. Roberts.

[BULLETIN, *Wagner Free Institute of Science, 1928*]

SODIUM ALUM

HENRY LEFFMANN AND LESTER W. STROCK

The word alum is derived from the Latin "alumen," but the significance that the word had to the Romans has little bearing upon the significance of the English word today. The Romans understood by it certain astringent substances, mostly natural products, of about the same nature as the Greeks designated by the term "stypteria," in both cases probably aluminum or ferric compounds or mixtures thereof. As a definite English word, "alum" is found as early as 1325, but, of course, without the technical significance it now has. Within very recent time, owing to certain commercial issues, much discussion has taken place as to the exact technical scope of the term, many American experts have been brought into the dispute and much printer's ink expended on it. The gist of the dispute is the attempt of certain parties that use sodium alum, to have it excluded from the group and designated only by a term indicating the detailed chemical composition (aluminum sodium sulphate) or by a convenient mask SAS, a method now quite frequent in trade.

The literature relating to sodium alum covers more than a century, and so far as exact and careful investigation goes, there is no reason to doubt that it belongs to the same group as potassium and ammonium alum. There is no justification for relegating it to an outside position. The greater difficulty of crystallizing it has been the bar to its early introduction in place of potassium alum, since it would be cheaper, the dominating motive in trade. Ammonium alum took the place of potassium alum about the time of the War between the States, when the obtaining of ammonium compounds from gas liquor made ammonium sulphate cheaper than potassium sulphate. The substitution was made without general notice and for some time people were using ammonium alum believing that it was the alum of their fathers. The principal point is that in all cases alum is used for the aluminum salt, the other salt is merely added to secure easily a well-crystallized form, aluminum sulphate alone being somewhat unsatisfactory. A proof of this statement is to be found in the course followed by United States Pharmacopeia, in which "alum" has always been an item. The first edition and the first three revisions listed potassium aluminum sulphate alone, designating no other similar salt. In 1860, the commercial production of ammonium aluminum sulphate led to its recognition under its systematic name, not as alum. In 1870, however, it became the offical compound brought about by the fact that it was the bulk of the alum on the market. Potassium

aluminum sulphate was relegated to a side status, under its systematic name. In 1880, 1890 and 1900 potassium alum came back to official recognition, ammonium alum going into the second place. In 1910 and 1920 the framers of the work threw up their hands and admitted both forms to the designation of "Alumen, U. S. P." Now, what is the "greatest common denominator" of this series of changes. Obviously, the aluminum sulphate. As long as it is part of the compound the substance is alum. Why should sodium alum stand like the Peri at the gate, disconsolately waiting for admission to fellowship. That the essential feature of an alum is the sulphate of the trivalent element (Al, Fe, Cr, for instance) is shown by the conventional naming of the several forms. Ferric alum contains ferric sulphate, chromic alum, contains chromic sulphate. It is a universal agreement among chemists and pharmacists that if the trivalent element is not indicated, it is aluminum. Berzelius expressed the logic of the question when he said that alum is the generic title and each form is specific. (Quoted in Turner's "Elements of Chemistry," 7th edition, Philadelphia, 1846.)

As a matter of fact, sodium aluminum sulphate has been designated as sodium alum for more than a hundred years, originally by those who first obtained it in the early part of the nineteenth century. The record lies open that all who run may read. A. F. Gehlen wrote shortly before his death (1815) to Jos. N. Fuchs that he had obtained the compound in the same form as the other alums. Fuchs makes this statement in a paper in *Jour. f. Chem. u. Phys.*, 1815, *15*, 377. (This publication is often termed Schweigger's Journal.) A year later Zellner took up the matter of the production and properties of the compound, publishing his work in the same journal (1816, *18*, 344), the title being "Über die dreifachen Verbindungen der krystallisirten schwefelsauren Thonerde." He states that he prepared sodium alum in August, 1815, but hesitated to publish the fact as he thought it might not be new. As noted above these early investigators found the great difficulty to be the crystallization. Heated above 40° C. it generally fails to give definite forms. By spontaneous evaporation at room temperatures characteristic crystals are obtainable. These statements have all been confirmed in our own work. Excellent and characteristic crystals have been obtained, showing that the molecular association of the two sulphates and the water of crystallization coincides with those in the familiar alums. No doubt can be entertained that if sodium alum was as easily crystallizable as the other alums it would have long since displaced them, on account of cheapness, but labor cost is such an important item in manufactures that it has not found general use. Its imperfectly crystallized form, however, is now a familiar article and has been seized upon as a means of introducing aluminum sulphate into food. The sulphate of the monovalent element serves only the purpose of securing a satisfactory form in which to present the sulphate of trivalent element. This is true of all the alums now in commerce. Ferric alum is used a means of employing a ferric salt in permanent and definite form, chrome alum for a similar reason.

Later studies confirm the positions here taken. James Locke in *American Chemical Journal* (1901, *26*, 166) on "Gradations in the Properties of the Alums," asserts that all compounds of the general formula $M'M'''(SO_4)_2\ 12H_2O$ in which M' is a monovalent element and M''' a trivalent one, are alums. He indicates nine trivalent elements that may form an alum, namely, Al, Fe, Cr, Ti, V, Ga, Co, Mn, and In. In the monovalent group, K, Na, Rb, Cs, and Tl are noted. Lithium is considered at present as not being capable of forming an alum, but lithium is markedly different in properties from the rest of the group with which it is placed in the periodic system. Ostwald said that sodium alum does not exist, a curious error in view of what has been done more than a century ago. Thallium may be expected to show some departure from the typical alum for it has relations with several other groups. Its discoverer, Crookes, called it the *Ornithorhynchus* of metals. W. R. Smith, also in *Jour. Amer. Chem. Soc.*, 1909, *31*, 247, extended the results of earlier workers.

Zellner, as noted above, made a very comprehensive study of sodium alum. He gives the following composition:

Sulfuric acid	34.522	(expressed as anhydride)
Alumina	11.1	
Soda	6.63	(expressed as anhydride)
Water	48.010	

Each datum was determined directly and the methods are given in detail. In comparing the data with a modern analysis it must be borne in mind that the atomic weights were not exactly those now used. The Berzelian system of symbols though published had not come into general use.

Zellner expressed clearly and distinctly the status of the compound as follows: "Der Kürze wegen, werde ich die schwefelsaure Natrumthonerde = Natrumalaun, so wie die schwefelsaure Kalithonerde = Kalialaun, benennen." "For brevity, I will call the sodium aluminum sulphate, sodium alum, just as potassium aluminum sulphate is called potassium alum." This decisive opinion by one who may be regarded as the first to present a complete account of the compound, seems to entitle the name to positive standing. It is unfortunately true that when powerful economic interests come into play many see, or imagine they see, distinctions and resemblances that are not appreciable to the mass of persons. Men may, and often do find

"* * * * * with keen discriminating sight
Black's not so black, nor white so *very* white."

Hence, sodium aluminum sulphate, which for more than a century has been accepted as sodium alum, is now denied that title. It may very appropriately be asked if it is not sodium alum what is it. The answer that we may get is that it is SAS!

In our own experiments we have reviewed the work of the earliest investigators and observing the conditions they indicated have

obtained results concordant with theirs. The methods usually employed to secure crystals by making a solution saturated at the boiling point and allowing the liquid to cool slowly does not work well with sodium alum, possibly because of the somewhat eccentric behavior of hydrated sodium sulphate, which as is known undergoes dehydration at a temperature far below 100°. Crystals have been obtained by evaporation at a moderate temperature, which have been shown by examination under polarized light to be isotropic similar to the well-known alums.

Sodium alum crystals (natural size)
Prepared and photographed by the authors.

Sodium alum is much more liable to effloresce than the common alums. A few minutes exposure to free air produces a white powdery material on the edges of the crystals. As we were able to operate only on comparatively small amounts, large groups of crystals such as are commonly seen with ammonium alum were not obtainable, but perfect octahedrons of about a centimeter on the edges were produced which were clear and brilliant. The most usual form is the octahedron modified by the cube. In some experiments monoclinic crystals were obtained and also true cubes but these are not usual.

Determinations of the refractive index gave results in close agreements with the figures given in the Smithsonian Institution tables of 1920; those of Bulletin 1108 (1922), U. S. Department of Agriculture and of Groth's "Chemische Krystallographie."

Our thanks are extended to the Wagner Free Institute of Science of Philadelphia, for assistance in the work and to the Philadelphia College of Pharmacy and Science for allowing the use of the laboratory equipment.

PUBLICATIONS OF THE INSTITUTE

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Vol. 1. Explorations on the West Coast of Florida and in the Okeechobee Wilderness. *Angelo Heilprin.* $2.50

Vol. 2.—Report on Fresh-water Sponges Collected in Florida. *Edward Potts.*
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Vol. 10.—Contributions by the Faculty of the Institute. Post-fixation Development. *H. Leffmann.* Reconstruction of Columbia Bridge. *S. T. Wagner.* Origin and Relationship of North American Song Birds. *S. Trotter.* The Three-Electrode Bulb in Radio Signals. *L. B. Seely.* Detection of Methanol in Presence of Ethanol. *C. H. LaWall.* Chemical Attraction. *D. W. Horn.* $2.00

Vol. 11.—Biochemistry of American Pitcher Plants. *Joseph S. Hepburn, Elisabeth Q. St. John and Frank M. Jones.* $2.50

Republication of Conrad's Fossils of the Medial Tertiary of the United States. Introduction by *William H. Dall.* Out of Print.

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Carl Boyer, *Director*

BULLETIN

OF THE

WAGNER FREE INSTITUTE OF SCIENCE

OF

PHILADELPHIA

VOLUME III, NO. 4, AUGUST, 1928

ANNOUNCEMENT

FOR

SESSION OF 1928-9

EIGHTY-FIRST YEAR

WAGNER FREE INSTITUTE OF SCIENCE OF PHILADELPHIA

SEVENTEENTH STREET AND MONTGOMERY AVENUE

PHILADELPHIA, PA., U. S. A

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The Wagner Free Institute of Science
Montgomery Ave. and Seventeenth St.

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WAGNER FREE INSTITUTE OF SCIENCE OF PHILADELPHIA

PUBLISHED BY THE INSTITUTE

Edited by the Publication Committee

HENRY LEFFMANN SAMUEL TOBIAS WAGNER

Vol. 3 No. 4	Bi-Monthly August, 1928	$1.00 per year Single numbers, 20 cents

WAGNER FREE INSTITUTE OF SCIENCE

Montgomery Ave. and Seventeenth St., Philadelphia, Pa., U. S. A.

HISTORICAL NOTE

The Wagner Free Institute of Science owes its establishment to the liberality and public spirit of William Wagner and his wife, Louisa Binney Wagner. In his early life Professor Wagner made extensive voyages in the service of Stephen Girard, and had opportunities to visit scientific institutions and make the acquaintance of scientific workers. He soon developed a strong interest in the natural sciences, especially geology and mineralogy, and devoted a large part of his life to studying these topics and collecting material to illustrate the teaching of them.

In 1847 he began to give free lectures at his home, near the present location of the Institute building, at that time in the rural section of the county. In 1855 the Institute was incorporated by the Legislature, a faculty was appointed and lectures were given at Commissioners' Hall, Thirteenth and Spring Garden Streets, by permission of the city authorities. In a few years the city was obliged, by its own needs, to withdraw the privilege of the hall, and Professor Wagner arranged to erect a suitable building on his own property. This was completed in May, 1865, and lectures at once given in it. In 1864 a deed of trust was executed by Professor Wagner and his wife, furnishing a permanent endowment of the Institute.

In 1885, by the death of the founder, the care of the Institute passed into the hands of a Board of Trustees, since which time many improvements have been made in the building, and extensive additions to the equipment in the museum and library and in scientific apparatus. In 1901 a wing was built for the use of a branch of the Free Library of Philadelphia.

FACILITIES FOR INSTRUCTION

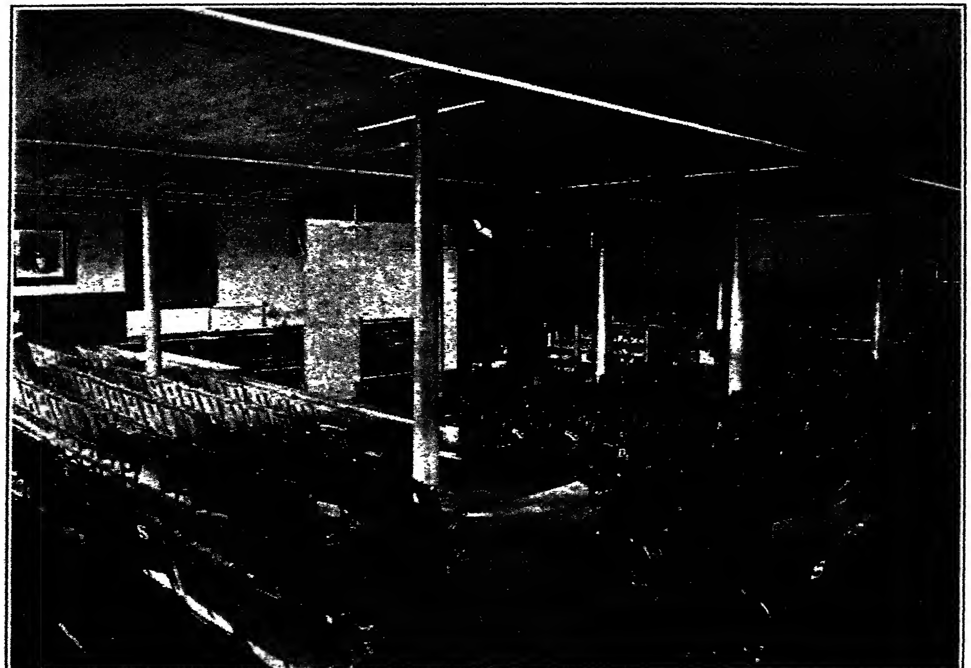
Lectures and Class-Work

Instruction at the Wagner Free Institute of Science is conducted by means of public lectures, supplemented by class-work, and is without charge and without restriction of race or sex. The class-instruction is given partly at the close of each lecture, partly by written exercises. The Museum and Reference Library of the Institute are available for aid in the instruction work and are freely used. In addition, the Wagner Free Institute Branch of the Free Library of Philadelphia affords abundant opportunities for collateral reading.

The lecture-hall is provided with the latest apparatus for lantern-slide and opaque projection, and a motion-picture machine.

At the close of each course of lectures an examination is held, to which those who have attended the classes are admitted, and on

Museum



Auditorium

passing such examination the pupil is awarded a certificate. Certificates are awarded at a public meeting held in May of each year.

The lecture courses are arranged to cover a given topic in four successive years, and to those who hold certificates for each of these courses a full-term certificate is issued.

MUSEUM

The Museum covers the whole field of natural science and contains illustrations in all departments of biology, geology, mineralogy, metallurgy, and engineering. The specimens are arranged so as to be easily studied and are open to inspection from 2 to 5 o'clock Wednesday and Saturday afternoons, except legal holidays.

Teachers with classes and others desiring to use the museum for special studies can, by applying at the office, gain admission any week-day, except holidays, as above stated, between the hours of 9 A. M. and 5 P. M.

The collections of the museum have been used for a number of years for instruction by means of "Museum Talks," as noted below, and by arrangement with work at Temple University and the Division of Science Teaching of the Board of Public Education those teaching General Science in the eighth and ninth grades of the Philadelphia public schools or preparing for such teaching may secure elective credits upon the completion of the work as follows:

General Science II

Monday,	7 P. M. to 8 P. M.	Museum Lecture.
	8 P. M. to 9 P. M.	Lecture Course—Botany and Zoology.

NOTE: Four semester hours of credit will be given for the complete Monday evening program.

Tuesday,	8 P. M. to 9 P. M.	Lecture Course—Inorganic Chemistry and Geology.
Wednesday,	8 P. M. to 9 P. M.	Lecture Course—Organic Chemistry and Physics.

NOTE: An additional two semester hours of credit per evening may be obtained by electing Tuesday or Wednesday evening.

Monday evening is a prerequisite for these, however.

Further information concerning these courses may be obtained at the Office of the Institute.

LIBRARIES

The Reference Library contains text-books and works of reference in all departments of science, encyclopedias, many works devoted to literature, and an assortment of dictionaries of English, classical

and foreign languages. It is open on all regular business days from 9 A. M. to 9 P. M., a librarian being in attendance to assist students.

The Circulating Library is a branch of the Free Library of Philadelphia. It is open every business day from 9 A. M. to 9 P. M. Books may be taken out under the usual rules of the Free Library. Many periodicals—American and foreign, scientific and literary—are on file.

BULLETIN

The BULLETIN of the Institute is bi-monthly. It contains information as to the methods of work of the Institute, announcements of additions to its collections and original contributions to science. The third volume is now in course of publication. The subscription price is $1.00 per year, single copies, 20 cents.

SPECIAL LECTURES

By the liberality of Richard Brodhead Westbrook, D.D., for many years a trustee of the Institute, and of his wife, Henrietta Payne Westbrook, provision has been made for lectures independent of the general courses of the Institute and covering a wide range of topics.

A list of lectures so far given and of publications thereof so far issued is printed on the third cover page.

Announcement of the course for 1929 will be made in a subsequent issue of the BULLETIN.

The *Philadelphia Natural History Society* meets on the third Thursday of each month, except June, July and August. These meetings are open to all persons interested in the subjects.

RESEARCH

The Institute has carried on research work since 1885, most of the results having been published in its Transactions and Publications. A list of these will be found on the second cover page. Results of research appear also from time to time in the BULLETIN.

The income of a special fund is available for research in chemistry.

CLOSING EXERCISES

In May of each year the courses of instruction are formally closed by a public meeting at which addresses are given and the certificates awarded.

At the closing exercises in May, 1928, after an address by Professor Samuel C. Schmucker, President of the Faculty, and awarding of certificates, Professor Emery R. Johnson delivered a lecture on "China."

FULL TERM CERTIFICATES AWARDED

ENGINEERING

Charles H. Seidel

BOTANY

Frank E. Draper — H. May Hunter — Milton K. Meyers

INORGANIC CHEMISTRY

Abraham Josel

ORGANIC CHEMISTRY

Milton K. Meyers

ZOOLOGY

Milton K. Meyers

GEOLOGY

Milton K. Meyers

1927–28 CERTIFICATES AWARDED

ENGINEERING 1

George A. Achenbach	Cedric Haring	Henry O. Lind
Robert B. Bowman	Emanuel Hocking	Wilfred R. Newton
Frank E. Draper	Chauncey R. Kay	Andrew Pataky
Paul O. Emerich	Monroe P. Lesher	Charles H. Seidel
Paul W. Gehris		Lawrence H. Tobias

BOTANY 1

Charles Collins	H. May Hunter	Ralph W. Miller
Frank E. Draper	Florence McIlravey	Mrs. Thomas H. Peacock
William Gilbert, Jr.	Milton K. Meyers	Henry C. Savage

INORGANIC CHEMISTRY 3

Frank E. Draper	Abraham Josel	Harold Poole
William Gilbert, Jr.	Milton K. Meyers	Joseph Popel
William Josephs		Manuel Tubis

ORGANIC CHEMISTRY 3

Walter F. Estlack	William Josephs	Manuel Tubis
	Milton K. Meyers	

ZOOLOGY 4

Charles Collins	William D. S. Gillette	Ralph W. Miller
Walter F. Estlack	H. May Hunter	Hugh S. Roberts
Edward H. Gillette	Mrs. Dorothy G. Lloyd	Henry C. Savage
	Milton K. Meyers	

GEOLOGY 1

Frank E. Draper	Emanuel Hocking	Milton K. Meyers
Edward H. Gillette	D. Brooke Johnson	Harold Poole
William D. S. Gillette	Dorothy G. Lloyd	Henry C. Savage
Katherine R. Guest		Carl H. Wolff

PHYSICS 2

Marguerite N. Dickey	Edward H. Gillette	Clive A. Henninger
Frank E. Draper	William Gillette	Chauncey R. Kay
Paul W. Gehris	H. L. Grabosky	Dorothy G. Lloyd

MUSEUM TALKS

Charles Collins — Ralph W. Miller — Hugh S. Roberts

REGULAR LECTURES, SESSION OF 1928–1929

ENGINEERING 2

PROFESSOR WAGNER

Civil Engineering Structures

Lectures begin at 8 P. M.

1. Friday, September 7.
   Foundations on Land. Designing the Footing. Preparation of the Bed.
2. Friday, September 14.
   Foundations on Land and Water. Foundations on Piles. Coffer Dams.
3. Friday, September 21.
   Foundations in Water. Open Caisson Process. Dredging through Wells. Pneumatic Caissons.
4. Friday, September 28.
   Masonry Construction. Stone Cutting. Preparation of Surfaces. Stone Masonry. Parts of a Wall.
5. Friday, October 5.
   Masonry Construction (Concluded). Ashlar. Rubble. Concrete. Brick Masonry. Retaining Walls, Piers, etc.

No Lecture Friday, October 12.

6. Friday, October 19.
   Framing in Wood and Steel. Wood Framing. Iron and Steel Framing. Joints. Rivets. Pins.
7. Friday, October 26.
   Bridges. Definitions. Classification. History.
8. Friday, November 2.
   Bridges (Continued). History (Continued). Beam Bridges.
9. Friday, November 9.
   Bridges (Continued). Plate Girders. Trusses.
10. Friday, November 16.
    Bridges (Continued). Trusses (Continued). Classification. Design of Tension and Compression Members.
11. Friday, November 23.
    Bridges (Continued). Trusses (Concluded). Details and Methods of Erection. Cantilevers.
12. Friday, November 30.
    Bridges (Continued). Suspension. Tubular. Arches (a) Stone; (b) Steel.
13. Friday, December 7.
    Bridges (Concluded). Movable Bridges. Viaducts.
14. Friday, December 14.
    Roofs. Types of Trusses. Special Designs for Train Sheds.
15. Friday, December 21.
    Details of Construction. Rivets, Riveted Work, Pins, Forging Details. Bridge Floors—(a) Railroad; (b) Highway.
16. Friday, December 28.
    Buildings. Design of Buildings of Wood, Steel, Reinforced Concrete, General Building Construction.

INORGANIC CHEMISTRY 4 *

PROFESSOR HORN

Chemistry of the Metals

Lectures begin at 8 P. M.

1. Tuesday, September 11.
   Iron. Principal sources and methods of extraction. Wrought iron, cast iron, and steel. Special steels.
2. Tuesday, September 18.
   Iron (continued). Compounds of iron. Distinction between ferrous and ferric salts. Methods of transformation. Biologic importance of iron.
3. Tuesday, September 25.
   Copper. Sources and methods of extraction. Alloys.
4. Tuesday, October 2.
   Lead. Sources and methods of extraction. Possible variability in atomic weight. Lead compounds. Importance of lead in industrial hygiene.
5. Tuesday, October 9.
   Mercury. Sources, preparation, properties. Two series of salts. Industrial uses.
6. Tuesday, October 16.
   Gold and Platinum. Occurrence, properties. Methods of gold mining. Industrial uses of gold and platinum.
7. Tuesday, October 23.
   Silver. Occurrence, properties. Methods of silver mining. Photosensitiveness of silver salts. Use of silver in coinage.
8. Tuesday, October 30.
   Cobalt, Nickel, and Cadmium. Occurrence, preparation, properties and uses. Alloys. Principal and secondary valence.
9. Tuesday, November 6.
   Tin, Tungsten, and Titanium. Occurrence, preparation, properties. Industrial uses. Differences between tinned and "galvanized" iron. Tungsten in electric lighting.
10. Tuesday, November 13.
    Alloys and Amalgams. Physical chemistry of alloys. Metallography. Occlusion of gases by metals.
11. Tuesday, November 20.
    Bismuth, Molybdenum, and Uranium. Occurrence, preparation, properties. Industrial uses.
12. Tuesday, November 27.
    Rare and Radio-Active Metals. Transformation of metals. Modern alchemy. Niton and other emanations from metals.

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* This course will be delivered by Sydney L. Wright, Jr., Ph.D., Dr. Horn having been granted leave of absence.

ORGANIC CHEMISTRY 4

PROFESSOR GRIFFITH

Compounds of Nitrogen

Lectures begin at 8 P. M.

1. Wednesday, September 12.
   Nitrogen Itself. Inert alone but restless in company. An essential ingredient of all living tissue. Proteins. Classification. Identification. General characteristics.
2. Wednesday, September 19.
   Proteins. Their rôle in animal diet. Protein foods. Calorific value. Important proteins—gluten, gelatin, casein, etc.
3. Wednesday, September 26.
   Protein Derivatives. The body's way of simplifying the complex proteins by its schemes of digestion. Pepsin, trypsin, etc. Derivatives of proteins —amino-acids, proteoses, peptones. The cinders of protein digestion—urea, creatinin, etc.
4. Wednesday, October 3.
   The Cycle of Nitrogen in Nature. Changing simple inorganic nitrogen compounds to complex organic bodies—and reverse. The nitrate beds of Chile. Soil and soil nutrition.
5. Wednesday, October 10.
   Man's Conquest of the Air. Not with wings, but with brains. Nitrogen fixation. Nitrogen—inactive—inert and useless—chained and put to work. The Haber process. Other fixation processes.
6. Wednesday, October 17.
   Miscellaneous Nitrogen Compounds. Vitamines and hormones. Regulators of living processes. Purines, amines, amides, urea, caffeine, theobromine and other odds and ends of nitrogen compounds.
7. Wednesday, October 24.
   Miscellaneous Nitrogen Compounds (continued). The cyanogen compounds. Plants that are poison factories. The bitter almond, wild cherry, peach, and hydrogen cyanide. Cyanamide.
8. Wednesday, October 31.
   Alkaloids. General characteristics. Origin—their rôle in plant life. Group reactions. Adsorption phenomena. Color reactions.
9. Wednesday, November 7.
   Alkaloids (continued). The Pyridine and Tropine group—Coniine—the Socratic poison. Nicotine—the democratic poison. Atropine—the mydriatic poison. Cocaine—the anæsthetic poison.
10. Wednesday, November 14.
    Alkaloids (continued). The Quinoline and Iso-quinoline groups. Quinine —bark of Peru, made famous by Jesuit fathers. Strychnine, the toxic and tonic alkaloid. Morphine, codeine, hydrastine, etc.
11. Wednesday, November 21.
    Alkaloids (continued). Artificial and miscellaneous alkaloids. Apomorphine, homatropine, heroine, emetine from ipecac, and sanguinarine from blood root.
12. Wednesday, November 28.
    Ptomaines and Allied Compounds. Ptomaines—toxins and toxalbumins. Facts and fallacies of food poisoning.

BOTANY 2

PROFESSOR KAISER

Taxonomy

Lectures begin at 8 P. M.

1. Monday, September 10.
Myxomycetes. Slime molds. The borderland of plants and animals. Habitat and life history. Remarkable plasmodia.

2. Monday, September 17.
Cyanophyceæ. *Schizomycetes*. Blue green algæ and bacteria. Early organisms. Plants that fix nitrogen. Algæ of hot springs and arctic regions. Red sea. Types and kinds of bacteria. Aerobe and anaerobe.

3. Monday, September 24.
Chlorophyceæ. *Phycomycetes*. Green algæ and algal fungi. Pond scum, desmids and diatoms. Molds and mildews. Sexual processes. Oögonia and antheridia. Conjugation.

4. Monday, October 1.
Phæophyceæ. *Rhodophyceæ*. Brown and red seaweeds. Giant kelp. Rockweeds and the Sargasso sea. Irish moss and dulse. Color in relation to light supply. Economic uses.

5. Monday, October 8.
Ascomycetes. Sac fungi. Truffle, Morel and Peziza. Chestnut-tree blight and other plant diseases. Ferment organisms. Molds. Complicated sexual development showing derivation from red algæ.

6. Monday, October 15.
Lichenes. Lichens. Plants composed of algæ and fungi. Symbiosis or helotism (?). Soil building and reproduction. Soredia and ascospores. Litmus, rock tripe, reindeer moss.

7. Monday, October 22.
Basidiomycetes. Basidio-fungi. Smuts of wheat, rusts of grain, etc., that live on two hosts. Mushrooms, edible and poisonous. Bracket fungi. Phosphorescent fungi.

8. Monday, October 29.
Hepaticæ. Liverworts. Green plants that have acquired a land habit. Alternation of generations. Gametophyte and sporophyte. Antheridia and archegonia. Sporangia and elaters. Thalloid and foliose forms. Development of stomata.

9. Monday, November 5.
Musci. True mosses. Green spore-bearing plants. Soil-formers. Protonema and gametophyte. Development of sporangia. Calyptra, operculum and peristome. Peat mosses. Andreæa. The order Bryales.

10. Monday, November 12.
Filices. True ferns. Life history. Prothallium. Sori, and sporangia. Adder's tongue and moonwort. The Polypody family. Lime-loving species and walking fern.

11. Monday, November 19.
Other *Pteridophyta*. Fern allies. Horsetails, club mosses and their kin. Fossils of the coal measures. Heterospory. Pteridosperms.

12. Monday, November 26.
Gymnosperms. Naked-seed plants. Life histories. Cycads and ginko, sole representatives of long-vanished families. The long-lived yew. Pines and other conifers. Gnetaceæ and the wonderful *Welwitschia* of the South African desert.

ZOOLOGY 1

PROFESSOR SCHMUCKER

The Animals Without a Backbone

Lectures begin at 8 P.M.

1. Monday, January 7.
The Environment. Water, salt, and fresh. Marshes. Dry land, forest, grass-land and desert.
2. Monday, January 14.
One-Celled Animals and Sponges. The great variety of one-celled animals. Their minute size. The fixed life of sponges. Their skeletons. Fresh water sponges.
3. Monday, January 21.
Jelly Fishes and Star Fishes. The simple hydra and the complex man-of-war. Coral islands. Star fishes, sea urchins, and sand-dollars.
4. Monday, January 28.
The Worms. A very varied group. May not belong together. The flat worms. The vinegar eel. The earthworms. The tendency to parasitism.
5. Monday, February 4.
Shell Fishes. Clams and oysters. The snails and their kin. Nautilus and the squids.
6. Monday, February 11.
The Jointed-legged Animals. The external skeleton. Its advantages of protection and musculature. The disadvantage of its rigidity. Shrimps, lobsters, and crabs.
7. Monday, February 18.
Hoppers, Dragons, and Bugs. The incomplete life changes. The love song of the insects. The plant destroyers.
8. Monday, February 25.
Flies, Beetles, and Butterflies. The piercing mouth. "Pinching bugs." The complete life change.
9. Monday, March 4.
Bees, Wasps, and Ants. The stinging insects. Solitary and social bees and wasps. The ant colony and its castes.
10. Monday, March 11.
The Spiders and Their Kin. Trilobites and king crabs. Scorpions, Daddy-longlegs. Mites and ticks. The true spiders. The spider web.
11. Monday, March 18.
The Road Higher Up. The relationship of groups. Links. The connection with the back-boned animals.
12. Monday, March 25.
Animals of the Past. The geological story. Its time scale. Race history and life history.

PHYSICS 3

Professor Seely

Light

Lectures begin at 8 P. M.

1. Wednesday, January 2.
   Historical. The development of the theory of light. The corpuscular theory. Newton. The electro-magnetic theory. Huygens and Maxwell. Galileo. Rumford.
2. Wednesday, January 9.
   Propagation of Light. Light travels in straight lines. Intensity of light. Law of variation of intensity. Shadows.
3. Wednesday, January 16.
   Propagation (continued). Brightness and illumination. Photometry. Speed of light.
4. Wednesday, January 23.
   Reflection of Light. Law of reflection. Mirrors and diffusing surfaces. Plane mirrors.
5. Wednesday, January 30.
   Reflection (continued). Curved mirrors. Principal focus, conjugate foci, and center of curvature. Images, real and apparent.
6. Wednesday, February 6.
   Refraction. Passage of light to denser and to rarer media. Index of refraction. The angle of total reflection.
7. Wednesday, February 13.
   Refraction (continued). Lenses and prisms. Principal focus and conjugate foci of lenses. Images by lenses.
8. Wednesday, February 20.
   Dispersion. Composition of white light. Complementary colors. Pigments.
9. Wednesday, February 27.
   Color Phenomena. Coloration by absorption and by reflection. Opalescence. Phosphorescence. Fluorescence.
10. Wednesday, March 6.
    Spectra. The solar spectrum. Fraunhofer's lines. Bright line and dark line spectra. The spectroscope.
11. Wednesday, March 13.
    Spectra (continued). Infra-red and ultra-violet light. Composition of the sun's light. Artificial lights.
12. Wednesday March 20.
    Interference and Polarization. Description of interference phenomena. Polarized light.
13. Wednesday, March 27.
    Optical Instruments. Magnifying glass. Compound microscope. Telescope.
14. Wednesday, April 3.
    Optical Instruments (continued). The projecting lantern. Opaque projection. Stereoscope. Binocular vision.

15. Wednesday, April 10.
    Photography. The camera obscura. The photographic process. Lens correction. Color photography.
16. Wednesday, April 17.
    The Eye and Common Defects of Vision. Nearsightness and far-sightedness. Astigmatism. Color-blindness.

GEOLOGY 2

PROFESSOR HOWELL

Physical Geology

Lectures begin at 8 P. M.

1. Tuesday, January 8.
   The Restless, Uneasy Earth. Its never-ceasing efforts to get comfortable. Why it never succeeds.
2. Tuesday, January 15.
   The Earth's Internal Troubles. How they affect its crust. Lavas that reach the surface and lavas that do not succeed in breaking through.
3. Tuesday, January 22.
   What the Lavas do Within the Earth's Crust. How lavas freeze. Magmatic differentiation. Magmatic ores.
4. Tuesday, January 29.
   What Lavas do When They Reach the Surface. Volcanoes. Fissure flows. Hot springs and geysers.
5. Tuesday, February 5.
   What Happens to the Lavas When They Rise above Sea-Level. Mother Nature's carving tools and how she uses them.

   No lecture February 12.

6. Tuesday, February 19.
   How the Hard Rocks are Broken up by the Processes of Weathering and Decay. Solution, frost action. The formation of soils.
7. Tuesday, February 26.
   The Earth's Transportation System. Water-borne freight. Wind-borne freight. Ice-borne freight.
8. Tuesday, March 5.
   Ice as a Geological Agent. Glaciers. Ice-caps. Icebergs. What the ice leaves behind it when it melts away.
9. Tuesday, March 12.
   What Becomes of the Water-borne and Wind-borne Freight. The great basins of deposition, where the products of erosion come to rest. How coal and oil are made.
10. Tuesday, March 19.
    How the Sediments Change into Rock. The different kinds of sedimentary rocks.
11. Tuesday, March 26.
    How the Transportation of Material from One Region on the Earth's Crust to Another Underloads the One Region and Overloads the Other, and What Happens as a Result.

12. Tuesday, April 2.
How the Earth's Crust Moves. Slow movements. Sudden shifts. Diastrophism. Folding. Earthquakes. Faulting.

13. Tuesday, April 9.
How Mountains are Formed. Folded mountains. Faulted mountains. Relict mountains.

14. Tuesday, April 16.
How Movements Affect the Rocks of the Crust. Metamorphism. Marbles. Quartzites. Schists.

15. Tuesday, April 23.
The Work of Underground Waters. Hot waters and cold waters. How they form ore deposits. How they make caves. Their relation to oil. Importance of underground waters to the civilizations of the future.

16. Tuesday, April 30.
The Stable and Unstable Parts of the Earth's Crust. Why some parts are relatively quiet while others move frequently. Do the Continents really drift?

SERIES OF MUSEUM TALKS

Monday Evenings at 7 o'clock

Sept. 24.	Mollusca—Characteristics and Classification of Mollusks.	Mr. Lawrence
Oct. 1.	Great Groups of Plants—Monocotyledons	Professor Kaiser
Oct. 8.	Ungulata—The Hoofed Animals. Rock Rabbits and Elephants	Miss Borden
Oct. 15.	Mollusca—Univalves	Mr. Lawrence
Oct. 22.	Mollusca—Bivalves	Mr. Lawrence
Oct. 29.	The Senses of Animals—Sight without Eyes	Professor Schmucker
Nov. 5.	Great Groups of Plants—Walnut and Willow Families	Professor Kaiser
Nov. 12.	Ungulata—The Hoofed Animals. The Odd-Toed Ungulates. Tapir. Rhinoceros. Horse	Miss Borden
Nov. 19.	Mollusca—Cephalopods	Mr. Lawrence
Nov. 26.	The Senses of Animals—Sight with Primitive Eyes	Professor Schmucker
Dec. 3.	Great Groups of Plants—Spurge Family	Professor Kaiser
Dec. 10.	Ungulata—The Hoofed Animals—Non-Ruminants among the even toes. Hippopotamus to Peccary	Miss Borden
Dec. 17.	The Senses of Animals—How insects see	Professor Schmucker
Dec. 24.	No Museum Talk on this date	
Dec. 31.	No Museum Talk on this date	
Jan. 7.	Great Groups of Plants—Pink Family	Professor Kaiser
Jan. 14.	Ungulata—The Hoofed Animals—Ruminating Ungulates—Camels and Llamas	Miss Borden
Jan. 21.	Mollusca—Land Mollusks	Mr. Lawrence
Jan. 28.	The Senses of Animals—Do Insects Hear?	Professor Schmucker
Feb. 4.	Great Groups of Plants—Mallow Family	Professor Kaiser
Feb. 11.	Ungulata—The Hoofed Animals—Round Horns and Flat Horns	Miss Borden
Feb. 18.	Mollusca—Pearl and Mother of Pearl Industry	Mr. Lawrence
Feb. 25.	The Senses of Animals—The Senses of Fishes	Professor Schmucker
Mar. 4.	Great Groups of Plants—Rue Family	Professor Kaiser

Mar. 11.	Ungulata—The Hoofed Animals—Cattle Family; Wild and Domestic	Miss Borden
Mar. 18.	Mollusca—Mollusks as Food for Animals and Man	Mr. Lawrence
Mar. 25.	The Senses of Animals—The Senses of Reptiles	Professor Schmucker
Apr. 1.	Great Groups of Plants—Maple and Holly Families	Professor Kaiser
Apr. 8.	Ungulata—The Hoofed Animals—The Sheep Cattle. Summary and Conclusion	Miss Borden
Apr. 15.	Mollusca—The Oyster Industry	Mr. Lawrence
Apr. 22.	Great Groups of Plants—The Myrtle Family	Professor Kaiser
Apr. 29.	The Senses of Animals—The Senses in Man	Professor Schmucker

MUSEUM TALKS (By Topics)

Monday Evenings at 7 o'clock

Mollusca

Mr. Lawrence

Sept. 24.	Characteristics and Classification of Mollusks
Oct. 15.	Univalves
Oct. 22.	Bivalves
Nov. 19.	Cephalopods
Jan. 21.	Land Mollusks
Feb. 18.	Pearl and Mother of Pearl Industry
Mar. 18.	Mollusks as Food for Animals and Man
Apr. 15.	The Oyster Industry

Great Groups of Plants

Professor Kaiser

Oct. 1.	Monocotyledons
Nov. 5.	Walnut and Willow Families
Dec. 3.	Spurge Family
Jan. 7.	Pink Family
Feb. 4.	Mallow Family
Mar. 4.	Rue Family
Apr. 1.	Maple and Holly Families
Apr. 22,	Myrtle Family

Ungulata—The Hoofed Animals

Miss Borden

Oct. 8.	Introduction—Rock Rabbits and Elephants
Nov. 12.	The Odd-Toed Ungulates—Tapir—Rhinoceros—Horse
Dec. 10.	Non-Ruminants—Among the Even-toes—Hippopotamus to Peccary
Jan. 14.	Ruminating Ungulates—Camels and Llamas
Feb. 11.	Round Horns and Flat Horns
Mar. 11.	The Cattle Family—Wild and Domestic
Apr. 8.	The Sheep Cattle. Summary. Conclusion

The Senses of Animals

Professor Schmucker

Oct. 29.	Sight without Eyes
Nov. 26.	Sight with Primitive Eyes
Dec. 17.	How Insects See
Jan. 28.	Do Insects Hear?
Feb. 25.	The Senses of Fishes
Mar. 25.	The Senses of Reptiles
Apr. 29.	The Senses in Man

GENERAL SCHEDULE OF REGULAR LECTURES

Subjects of courses in each of the four successive years constituting a full term.

ENGINEERING

1. Materials of Engineering Construction.
2. Civil Engineering Structures.
3. Roads, Railroads and Tunnels.
4. Water Supply, Sewers, Canals, Rivers and Harbors.

PHYSICS

1. Properties of Matter. Mechanics.
2. Heat and Sound.
3. Light.
4. Electricity and Magnetism.

INORGANIC CHEMISTRY

1. General Principles, Notation, Nomenclature.
2. Descriptive Chemistry.
3. Descriptive Chemistry.
4. Descriptive Chemistry.

ORGANIC CHEMISTRY

1. General Principles. Aliphatic Hydrocarbons.
2. Carbohydrates, Fats, Oils and Waxes.
3. Cyclic Hydrocarbons.
4. Compounds Containing Nitrogen.

ZOOLOGY

1. Invertebrate Animals.
2. Vertebrate Animals.
3. Human Biology.
4. Principles of Animal Life.

BOTANY

1. Morphology.
2. Taxonomy.
3. Taxonomy (continued).
4. Physiology and Ecology.

GEOLOGY AND PALEONTOLOGY

1. Physical Geography.
2. Physical Geology.
3. Paleontology.
4. Historical Geology.

LECTURES UNDER RICHARD B. WESTBROOK FOUNDATION

1912.—Ancient Civilization of Babylonia and Assyria. *Morris Jastrow, Jr., Ph.D.*

1913.—Conservation of Natural Resources.
Gifford Pinchot, Marshall O. Leighton, Overton W. Price, Joseph A. Holmes.

1914.—The Theory of Evolution. *William Berryman Scott, Ph.D., LL.D.*

1915.—Invisible Light. *Robert Williams Wood, LL.D.*

1916.—Aspects of Modern Astronomy. *John Anthony Miller, A.B., A.M., Ph.D.*

1917.—Heredity and Evolution in the Simplest Organisms.
H. S. Jennings, B.S., A.M., Ph.D., LL.D.

1918.—The Chemistry, Nutritive Value and Economy of Foods.
Harvey W. Wiley, A.M., M.D., B.S., Ph.D., LL.D., D.Sc.

1919.—The Origin and Antiquity of the American Indian. *Aleš Hrdlička.*

1920.—Chemistry and Civilization. *Allerton S. Cushman, B.S., A.M., Ph.D.*

1921.—Microbiology. *Joseph McFarland, M.D., Sc.D.*

1922.—Evolution of the Human Face. *William K. Gregory, Ph.D.*

1923.—The Philosophy of Sanitation. *George C. Whipple, B.S.*

1924.—The Distribution of American Indian Traits. *Clark Wissler, A.M., Ph.D.*

1925.—Structural Colors. *Wilder D. Bancroft, Ph.D., Sc.D.*

1926.—The Animal Mind; its sources and evolution. *George Howard Parker, Sc.D.*

1927.—An Interpretation of Atlantic Coast Scenery. *Douglas W. Johnson, Ph.D.*

1928.—The Science of Musical Sounds *Dayton C. Miller, Ph.D.*

WESTBROOK FREE LECTURESHIP PUBLICATIONS

Can be purchased through any book-store

Ancient Civilization of Babylonia and Assyria, by *Morris Jastrow, Jr.* J. B. Lippincott Co.

The Theory of Evolution, by *William Berryman Scott.* The Macmillan Co.

Life and Death, Heredity and Evolution in Unicellular Organisms, by *H. S. Jennings.* Richard G. Badger.

Chemistry and Civilization, by *Allerton S. Cushman.* Richard G. Badger.

Fighting Foes too Small to See, by *Joseph McFarland.* F. A. Davis Co.

The Relation of Nature to Man in Aboriginal America, by *Clark Wissler.* Oxford University Press.

BULLETIN

of the

WAGNER FREE INSTITUTE OF SCIENCE OF PHILADELPHIA

PUBLISHED BY THE INSTITUTE

Edited by the Publication Committee

HENRY LEFFMANN SAMUEL TOBIAS WAGNER

Vol. 3	Bi-Monthly	$1.00 per year
No. 5	October, 1928	Single numbers, 20 cents

ANNOUNCEMENTS

THE courses of lectures and museum talks began as scheduled and have continued without interruption, with satisfactory attendance. During the vacation period the reference library room has been extensively remodelled, interfering partitions having been removed so as to make one large room with convenient reading space and improved lighting. The business office has been placed near the main entrance to the Institute. Additions have been made to the equipment and to the several collections.

Professor Horn was granted leave of absence for the session of 1928–9 and Sydney L. Wright, Jr., Ph.D., was appointed to conduct the course in Inorganic Chemistry as scheduled.

Several special lectures have been arranged, the dates and subjects of which will be announced later. Provision is also being made for the issue of publications covering special research.

Entered as second-class matter, September 10, 1926, at the Post Office, Philadelphia, Pa., under Act of August 24, 1912.

SYDNEY TUTHILL SKIDMORE, Sc.D., Litt.D.

August 19, 1844 — August 22, 1928

In the death of Professor Sydney T. Skidmore the Wagner Free Institute of Science has suffered a very great loss. A member of its Board of Trustees since its organization in 1885, he came to its duties strengthened by a warm friendship with its Founder, by which he acquired an accurate knowledge of the purpose of the Institute and its aims; and during the 43 years of its active work he served it with a very marked degree of zeal and faithfulness. Always punctual in attendance at meetings—often under severe physical difficulties—prompt and efficient in every duty, and inspired by a true love of the Institute and recognition of its high purpose, he stood for all that was best in the work we had to do. His clear thinking and accurate judgment commanded our respect and admiration; his kindness and gentle courtesy won our affectionate regard. He was not only loyal to the Institute, he was its true and faithful servant for 43 years.

We need not speak at length of his career in the field of education. He organized with great care the Department of Physics of the Institute and served as its Professor of Physics for 7 years. His work in a difficult sphere of education in Philadelphia is recognized as an important part in the large development during the last 30 years in the higher branches of education in our public schools.

His wife was the trusted friend and close companion of our Co-Founder, Louisa Binney Wagner, for many years, and until the close of her life. From such companionship she learned to love the Institute as its Founders did, and has never failed in all these years to help her husband and his colleagues in the good work we had to do. With deep feeling we extend to Mrs. Skidmore our grateful acknowledgments and our heartfelt sympathy in her bereavement.

From the Minutes of Trustees' Meeting October 17, 1928.

THE ANCESTORS OF THE ELEPHANTS

By W. Henry Sheak

The present study is based on the splendid collection of fossil proboscidians in the American Museum of Natural History, New York City. While this institution does not possess a mounted skin of the mammoth, as does the Imperial Academy of Sciences of St. Petersburg (now Leningrad), it exhibits what is, perhaps, the most complete synoptic series of ancestral elephants shown in any museum of the world today.

The elephant, like man himself, presents at one and the same time the anomaly of a broadly generalized type and a form specialized to an extreme degree. The generalization is found in the plantigrade, pentadactylous foot; the persistence and relative position of the ulna and fibula; the complete series of carpal and tarsal bones; the simple stomach and liver; the archaic organization of the brain, leaving the cerebellum completely uncovered by the cerebral hemispheres, although the latter are very large and richly convoluted, and in the primitive permanent retention of the male gonads within the abdomen. The high specialization is manifest in the skull, the molar teeth, the tusks and the trunk. As elephants, the fossil forms as well as the living species are classified primarily by the structure of the molar teeth. I shall review briefly the characters of these great grinders and add a few words concerning the tusks, as the number and location of these latter determine the taxonomic position of some of the ancient forms.

Perhaps it is better to begin with the tusks, as it was the development of these great structures that inaugurated the differentiation of the elephants from the primitive ungulates. Whether in the upper or lower jaw, the tusks are always the enlarged and specialized second incisor on each side. Doubtless the original purpose of the tusks was the digging up of roots for food and the uprooting of small trees on the branches of which their owner browsed. The African elephant of today is such a persistent and industrious digger that he almost always has the right tusk, which bears the brunt of the toil, worn several inches shorter than its fellow. The Indian species digs much less, feeding largely on grass and leaves low enough to reach with the trunk, and consequently the tusks never equal those of his African cousin in size, those of the female rarely protruding beyond the lips and those of the male likewise often merely vestigial.

The weight of the tusks made it necessary to shorten the neck, as it would be difficult to support and wield such heavy tools at a distance from the body, just as it is much harder to lift a heavy object at the end of a lever far from the fulcrum than it is with the

weight near the fulcrum. We all know it is easier to hold a weight in the hand near the body than at arm's length. But when the neck was shortened the owner had difficulty in feeding, for he could not reach the ground. Then the nose and the upper lip were developed into a proboscis or trunk with which to procure his food and water. This, however, did not solve the problem, since the trunk added more weight to the head, and the neck must become still shorter. Then, too, great strength was required to use the tusks efficiently, so the height and bulk of the animal were increased. The head was being lifted farther and farther from the ground. The tusks and trunk were both lengthened, adding still more pounds, which necessitated a further shortening of the lever between the weight and the fulcrum. Both the neck and the head were shortened. *Mœritherium*, the oldest true proboscidian, had a long head like a horse. This was reduced till it became the short, upright head of present-day elephants. This shortening of the head was not effected so much by the reduction in size of the component elements, as by a change in their position, as has been pointed out by Dr. William K. Gregory. As the head became shorter anteroposteriorly, it attained a great height. In an Indian elephant executed at the winter quarters of the Wallace circus near Peru, Ind., a number of years ago, and measured by me, the line from the base of the trunk to the top of the forehead was 4 feet 1 inch. Unfortunately I did not measure from the under margin of the lower jaw to the top of the head; this doubtless would have added six inches or more to the vertical line. Thus for many thousands of years Nature was striving to strike a balance between the efficiency of the enormous battery of tusks and the animal's ability to support and wield them.

In both *Mœritherium* and *Palæomastodon*, the two oldest known proboscidians, there were both premolars and molars, preceded by milk molars, and the succession was a vertical one, as in most mammals. The complete series of adult premolars and molars were all in place and functional at one and the same time. But as the head was shortened in the process of evolution, the jaws were so reduced in the horizontal line that there was not room for the complete series. The succession had to be radically modified. In living elephants there are never more than three molariform teeth visible at one time in each half of each jaw, above and below. There may be the remnant of a worn tooth in front, then a fully developed functional tooth, followed by one only partially erupted. As one molar is worn away it is pushed forward and replaced by a new one. While this is called a "horizontal" succession, it is not strictly so, for in the process of head-shortening the jaws have been so bent that

the upper teeth come into place along a curve from above downward and forward, and the lower teeth from below upward and forward. It would be more correct to say the succession is a diagonal one. There may be in all six molariform teeth in each half of each jaw, above and below. The first three are usually considered premolars and the remaining three, molars. They increase in size and complexity from before backward. The tusks are preceded by milk incisors, but these are shed at a very early stage. Since the days of *Mœritherium* there have been no canines in any elephant, and he had the upper canines only.

The structure of the crowns of the molars has increased in complexity from the earlier forms down to the living species. At first there were developed a few transverse ridges of dentine, more or less covered with enamel. The number of these ridges was increased from genus to genus. Then the ridges began to break up into cones or nipple-like tubercles. This phase of structure reached its maximum of development in the mastodons, where the surface of the tooth shows a number of transverse miniature mountain chains broken up into separate, closely approximated conical peaks. The whole crown of the molar is covered with a thick coat of very hard enamel. The name "mastodon" comes from two Greek words meaning breast and tooth, from these nipple-like tubercles. In the mammoths and modern elephants there is a long step forward. The transverse ridges become transverse vertical plates of dentine covered with enamel. Their numbers are considerably increased and the spaces between them are filled with cement, so that the plates protrude but slightly above the surface of the tooth. In other words, the crown is practically a flat surface, instead of a hillocky region, as in the mastodons. In time the enamel wears from the top of the plate, presenting in the worn tooth of a modern elephant one of two distinct patterns according to the species. In the African animal the enamel of one side of the vertical plate is a straight line or slightly indented in the middle portion, while the opposite side is pushed out into a considerable protuberance, so that the worn crown of the plate is said to have a lozenge shape. In the Asiatic elephant the sides of the plates are bent neither inward nor outward. They have neither indentations nor protuberances. They are straight lines and give the plates the form of greatly elongated, laterally compressed ellipses. I have called the sides of these enamel-covered plates "straight" lines, but they are not straight, as they are finely wavy or serrulate. The molar of the Indian species has a larger number of these transverse plates than that of his African cousin, and they are of still finer structure.

Dinotherium was not in the line of true ancestral elephants, nor was he the earliest proboscidian known, but he deserves mention here on account of his very great size and the presence of tusks, not in the upper jaw, but in the lower. The name is from the Greek and means terrible or mighty animal. He was bigger than any other elephant that has ever lived, for he is believed to have reached sometimes a length of head and body of eighteen feet, exclusive of the tail and any trunk he may have had. He is known only from his tusks and the bones of his head, which have been found in Europe and Asia, but not in America. He lived in the Miocene and Pliocene, then became extinct, leaving no descendants. He had incisors in the upper jaw, but we are not certain just how many. He had two incisors in the lower jaw, developed into great tusks, but no canines in either. He had two premolars and three molars in each half of each jaw, all in position at once, the premolars replacing milk molars as usual in diphyodont mammals--those having two successive sets of teeth. The molars have a structure something like those of the mastodon, but instead of tubercles there are high transverse ridges extending clear across the tooth. In the upper jaw, however, and especially forward, in the American Museum specimen, at least, these ridges are scooped out in the center, giving something the appearance of separate tubercles. The tusks extend downward from the depressed ends of the lower jaw and are sometimes eighteen inches or more in length, with the distal ends curved backward. The head and neck had already undergone considerable shortening. There was doubtless a trunk of some length. These animals were probably semi-aquatic in habits. There are several species, the best known of which is *Dinotherium giganteum* from Eppelsheim, near Mainz, Germany.

In the Lower Oligocene formations of Fayum, Egypt, Dr. Henry Fairfield Osborn, of the American Museum of Natural History, found the fossils of a much smaller creature, only about the size of a tapir, which he named *Mœritherium*, after the fabled Lake Mœris of ancient writers, supposed to have been in this neighborhood. This form has been claimed as the earliest ancestor of the elephants and while it is almost certain that the creature was not in the direct line of descent, yet it is a very primitive proboscidian, probably not far from the common ancestral stock, whence are derived the mastodons and elephants on the one hand and the sirenians on the other. It shows the complete series of teeth in both jaws, except one lower incisor, the lower canine and the first premolars, which are wanting. The molars have the simple cross-crested pattern from which the more complex grinders of modern proboscidians are derived. The

upper and lower second incisors are here slightly enlarged. The form of the skull is long and very different from that of any later proboscidian—more like that of primitive sirenians. There was probably no trunk at all; at least, it was no longer than the proboscis of a tapir. While *Mœritherium* had so little in common, superficially, with modern elephants, it was really of more importance than *Dinotherium*, because it shows the first rudiments of tusks in the upper jaws, the real tusks of modern elephants. We now have the first start in the long line of true proboscidians.

Phiomia and *Palæomastodon* are also from the Oligocene of Fayum, Egypt. The former is ancestral to the long-jawed mastodons which flourished in the Old World and North America in the later Tertiary. They are of small size and do not differ radically from *Mœritherium*, but have begun to develop the long, narrow lower jaw. The next stage is the *Trilophodon angustidens* of Cuvier, which spread all over Europe in Miocene time. Closely related species spread over Africa and North America, reaching this country in the Upper Miocene, and flourished till the end of the Tertiary period. A few survived until the Pleistocene or age of man. In one species the upper tusks are bent down so as to cross the tips of the short and chisel-like lower pair. It must have had an extremely elongated muzzle, formed by the upper lip and nose above and the lower lip below, with which it was able to reach the ground, the neck being rather longer, probably, than in modern elephants.

T. productus of Cope is of the Lower Pliocene, Clarenden beds, Donley County, Tex. It is the earliest American stage of the long-jawed mastodons, descending from the *Phiomia* of Egypt. But it is far advanced over the latter. It is much larger and the tusks are rootless, growing continuously during life. This is a great advance and the beginning of a modern character. The milk molars and premolars were much reduced in size and lost early in life, old animals having only two or three grinders on each side of the jaw. The upper tusks had a strip of enamel on the outer side and curved downward instead of upward. The lower tusks were of considerable size. The front of the jaw was extended in a long, spout-like process, on which the trunk rested, instead of hanging free, as it does in true mastodons and elephants. It was probably a little-changed survivor of the early mastodons that came into America from the Old World in the Middle Miocene. *T. giganteus* was still larger and more specialized, though not much younger geologically. In the *T. campestris* of Cope, from the Lower Pliocene, Republican River beds, Rawlins County, Kan., the upper tusks are very heavy and long, curving slightly downward and outward. The specimen in hand has

lost the lower tusks, but they were probably shorter and smaller than the upper ones, much like those of *T. productus*. The *T. serridens* of Cope is another primitive long-jawed mastodon. The specimen is from the Upper Miocene and from the same beds as the *T. productus* studied. It is a larger species than *T. productus*. The tusks are longer and thicker. The front of the jaw is bent downward. The molars show some mastodon characters.

Perhaps the maximum of development in these four-tusked elephants is reached in the *Megabelodon lulli* of Barbour. The specimen is from the Lower Pliocene of the Oak Creek beds, near Dallas, S. D. While it is a considerable advance over the forms named in the paragraph above, this long-jawed mastodon is still in many respects more primitive than the true mastodons. It is characterized by the very long jaws, the stubby lower tusks, the nearly straight upper tusks and the structure of the molars. The upper jaw is considerably produced, the lower very much so, being about 4½ feet in total length, and very slender, the two tusks being very close together. The lower tusks are short, protruding about 7 inches only, according to the restoration. The upper tusks are about 2½ feet long, slightly decurved. The front part of the molars show an irregular, hillocky surface, while behind they exhibit the large tubercles of the true mastodons, seemingly derived from the breaking up of transverse ridges, as they are arranged in orderly lines. The skull is much smaller than in *Mastodon*, owing chiefly to the lack of bony tissue over the brain case, and the limbs, especially the fore limbs, are shorter, though no less massive. The trunk was doubtless shorter and very different in appearance, being supported on the long, extended lower jaw instead of hanging free.

It might be well to note here that the generic terms *Tetrabelodon* and *Gomphotherium* are often used as synonyms for *Trilophodon*, the group of elephants with four tusks. W. B. Scott of Princeton claims that *Gomphotherium* has priority over the other two, but I have retained *Trilophodon* because it is the name used by the American Museum and I do not wish to enter into a discussion of nomenclature.

The Museum has the skull and tusks of *Dibelodon* (Stegomastodon) *mirificus* from the Pliocene of Texas. This is a two-tusked mastodon, having tusks in the upper jaw only. These were well developed, of an elongated, spiral form, and had prominent enamel bands. The molars are very primitive, but the enamel on them is well marked, showing white. The lower jaw was quite short, though the symphysis was longer and more trough-like than in living forms. The trunk was probably pendent. Some of the species ranged into

South America and quite high in the Andes. It is doubtful if this form was ancestral to true mastodons and elephants.

Going back to *Palæomastodon* we find ourselves among the ancestors of the true mastodons and elephants. These forms ranged in size from a tapir to a half-grown Indian elephant and were more elephant-like than *Mœritherium*. They were doubtless dwellers on solid ground and denizens of forests. The upper tusks were short, compressed, directed downward and slightly divergent, and had a broad band of enamel on the outer side; the lower tusks were still shorter, pointing straight forward, and were covered with enamel, which was very thick on the lower side and thin or wanting on the upper. All of the grinding teeth were in place and functional at the same time, which is not true of any of the later genera, and each of the premolars had its predecessor in the milk series, which it succeeded and displaced in the normal vertical manner. Both premolars and molars were small. The latter were characterized by three transverse ridges. All the bones except the skull and the teeth were very similar to those of modern elephants, but their limbs were rather lightly built. The neck was relatively long, the skull long and narrow, having a high and crested occiput (a mastodon character), and was projected forward into a long process. There was probably a long and flexible snout rather than a true proboscis. The symphysis of the lower jaw was prolonged beyond the ends of the upper tusks and this implies that the lower lip had a corresponding prolongation. A palate from the lower beds of the Upper Eocene of Fayum, Egypt, shows six molariform teeth on each side, very primitive and generalized in structure. The front one on each side is considerably enlarged and more like a canine, but may be an incisor—the primitive tusk. In two skulls, both from the Lower Oligocene of Fayum, there are tusks in both the upper and lower jaw, those of the lower protruding straight forward, while those of the upper bend downward and outward (true generic characters), in form and size much resembling a large tusk of *Sus scrofa*, the European wild boar, with its sickle shape. The rostrum is greatly produced or lengthened.

The Museum exhibits casts of the jaws and palate of *Mastodon longirostris* Kaup from the Lower Pliocene of Eppelsheim, Germany. The originals are in the Darmstadt Museum. This is a true mastodon, although it resembles the *Trilophodon* group in the very long jaws. The molars show mastodon characters, but with a suggestion of the mammoth. There is also the cast of a skull of *Mastodon silvalensis* from the Pliocene of the Siwalik Hills, India. The original is in the British Museum. It shows the broken remains of tusks.

The molars have the criss-cross or vertical laminate structure, but of a very primitive type.

It seems that the mastodons and mammoths evolved at about the same time in the Old World and invaded North America toward the end of the Tertiary. There were a dozen or more species of mastodons, but the genus reached its culmination in the great American mastodon. It was a creature about the height of the living Indian elephant, but longer and more robust, with immense pelvis and massive limb bones. The tail was very long, all but reaching the ground. The forehead was low, but there was a high occipital crest. The tusks of the lower jaw were vestigial, apparently present in the male only, and soon shed. The upper tusks sometimes reach a length of ten feet or even more. They were not so sharply curved as in the elephants, but were very heavy at the base, tapered rapidly, and were curved inward at the tips. The most prominent diagnostic character of the mastodons are the large nipple-like tubercles on the crowns of the molar teeth, arranged in orderly transverse rows. They have six grinders in each half of each jaw. Osborn thinks the ears were smaller than in the Indian elephant. The body was probably covered by long coarse hair, the pelage being known from one specimen found frozen in the ice, according to a label in the Field Museum, Chicago. These great creatures inhabited Russia, Siberia and North America in the Pliocene and Pleistocene. They were common in glacial times. According to the estimates of Osborn and Barrell, the mastodon became extinct in North America twenty thousand years ago.

The American Museum has the skull and jaws of a young *Mastodon americanus* from Rochester, Ind., well illustrating the typical mastodon molars. There is also the skull of a young adult male from Ashley, Ind., the youth of the specimen being indicated by the moderate wear of the teeth, the first molar being still in use and the last one in the jaw being unworn. The bull mastodon, like the bull elephant, had a larger skull with heavier tusks and more powerful muscle attachments. The tusks are six or eight inches in diameter at the base and nearly ten feet in length. Another skull, from Fulton, Ind., is that of a female. Like the living African elephant, both sexes of this species had tusks, but the ones in the female were much smaller than those of the male. Her skull was notably smaller, with less massive muscle attachments. The tusks are three or four inches in diameter and about five feet long. The specimen was an old cow, as is shown by the wear of the molars, the first being lost and the second and third much worn. The molars are in a fine state of preservation. The public library at Peru, Ind., has a fine mas-

todon molar in an excellent state of preservation. It has the typical mastodon tubercles well developed. It was retrieved near Peru. One of the most complete skeletons is the Warren mastodon, taken from a peat bog in Orange County, N. Y., in 1845. It is in the New York State Museum at Albany. Its height is 11 feet, length 17 feet, and it has a tusk 10 feet 11 inches in length. The Field Museum in Chicago has a fine skeleton.

Between the mastodons on the one hand and the mammoths and true elephants on the other, are several forms having their grinders transitional. The spaces between the transverse ridges are partially filled with cement and the ridges themselves are less broken into tubercles. In the worn tooth they show a tendency to form the lozenge or flattened-ellipse pattern. These three or more species are placed in a genus called *Stegodon*. *Mastodon* has from two to five transverse ridges on the grinders; *Stegodon* about thirteen and *Elephas* (mammoths and elephants) from eighteen to twenty-seven. The name *Stegodon* is given on account of the roof-like character of these ridges, the summits of which are broken into five or six small rounded prominences.

In the Field Museum is the cast of a skull of *Stegodon insignus* from the Siwalik Hills, India. The original is in the British Museum. The tusks are enormous, measuring about ten feet along the outer curve and having a well-proportioned diameter. One pair is known 12 feet 9 inches long and 2 feet 2 inches in circumference.' The species appears not to have exceeded the existing elephant in bulk. It is from the Pliocene beds and lived, according to the label, about five million years ago. In the American Museum is the cast of a skull of *S. bombifrons* from the same formation in the Siwaliks. The original is likewise in the British Museum. There are remnants of tusks in the sockets of the upper jaw. The grinders of the lower jaw show in their forward portion thin plates raised considerably above the level of the cement, much as in the present African species, but in the center of the posterior border of each plate there is a bending outward into a sort of a horizontal cone pointing toward the back of the mouth. The back half of the tooth is without these procumbent cones, but has each plate broken into sections; at first, near the middle of the tooth, three in number, but at the rear four in number. These may be reduced, modified tubercles.

The mammoths were true elephants, belonging, with the two living species, in the genus *Elephas*. Flower says tusks were present in both sexes. According to Lucas, the largest tusks ever measured were two from Alaska, one 12 feet 10 inches long, weighing 190 pounds, the other 11 feet in length and weighing 200 pounds. Some were nearly

straight while others were bent into almost a complete circle. They almost always spread or diverged, but in some specimens the distal ends turned inward. A skull in the American Museum has the tips of the tusks actually crossing each other. Doctor Lull, of the Peabody Museum of Yale, speaking of this pair of tusks, says: "They seem to represent an instance of a certain acquired momentum of evolution carrying them past the stage of greatest usefulness to become a natural detriment to their owner. This may have been an important factor for extinction." The molar teeth reached the maximum of development in the mammoths, the grinders of *Elephas primigenius*, the northern or hairy mammoth, reaching a more advanced stage than in the living Indian elephant. The plates are slightly more numerous on the average and of finer and more beautiful structure. These teeth are of enormous size, reaching their maximum in *E. columbi*. An upper molar in the National Museum at Washington is 10½ inches high, 9 inches wide, and the grinding surface 5 x 8 inches. It weighs 15 pounds, came from Oklahoma and is in a fine state of preservation. A lower grinder is 12 inches long and the crown 3½ x 9 inches. This species reached the maximum in the shortening and heightening of the skull. There were sixteen or more well-defined species. In size most of the species did not exceed modern elephants, attaining a height of not more than eight or nine feet. There were two or three species in Malta and Cyprus only about the size of a sheep. But there were three or four forms that considerably exceeded any modern proboscidian in size. These animals ranged well over Europe, Asia and North America and in time throughout the Upper Pliocene and clear through to the very end of the Pleistocene.

A skeleton of the gigantic *E. meridionalis*, the so-called Southern Elephant of Europe, in the Jardin des Plantes, Paris, measures 13 feet 1 inch at the shoulders. *E. antiquus* was another giant, found in England and the north of the Continent. It is known as the straight-tusked elephant. It shows a structure midway between the African and Asiatic species of today. *E. imperitor* of Leidy ranged from Ohio to California and southward into Mexico, possibly as far as French Guiana. The grinders were of enormous size. A femur reported from Texas is 5 feet 4 inches in length and a humerus 4 feet 3 inches, these being the longest bones on record, indicating an animal 14 feet high. A skull from Texas in the American Museum has a pair of tusks measuring 13½ feet along the outside of the curve. The estimated height of the animal when alive was 13 feet. A fore limb from Tule Cañon, northwest Texas, has a height of

11 feet 3 inches. The height of the fore limb of Jumbo, Barnum's famous African elephant, was but 10 feet.

E. columbi, too, was of great size. The splendid skeleton for many years in the Chicago Academy of Sciences, but now in the Field Museum, Lucas thinks is of this species. It came from the state of Washington and for a long time was the only complete mounted skeleton of a mammoth in this country. It is still one of the most complete skeletons to be seen anywhere, very few of the bones being missing and restored. The animal was about 13 feet high when alive. The tusks measure 9 feet 8 inches along the curve. The femur is 5 feet 1 inch in length, a foot more than that of Jumbo. The habitat of this species was northern Mexico and the entire United States south of a line drawn from Washington state to Washington city. The northern part of its range overlapped that of the Hairy Mammoth.

The skull, pelvis and other parts of the skeleton of a female from Rochester, Ind., now in the American Museum, well illustrate the fact that the female mammoth, like the female elephant of today, is smaller than the male, with shorter and more slender tusks, not much curved. One tusk in this skull had been broken off in life and afterward worn by use. The pelvis, in spite of its smaller size, has a larger pelvic opening than in the male. A fine skeleton of this species in the same Museum was discovered in the spring of 1904 on the Gift farm near Jonesboro, Ind. It was embedded in a peaty deposit, probably of Middle Pleistocene age, eight feet below the surface. The tusks when found were complete and unbroken, but were damaged in removal. All the upper parts of the animal were present, but were somewhat damaged by unskilful workmen. The tail and most of the limb bones were missing. These parts were restored from casts of the limbs and feet of the great skeleton of the closely related European species, *E. meridionalis*, in the Museum of Palæontology, Jardin des Plantes, Paris. They were proportionately reduced and remodeled to match this skeleton in size. The measurements are: Height at shoulders, 10 feet 6 inches; base of tusks to drop of tail, 13 feet 3½ inches; length of right tusk, inside curve, 11 feet 4½ inches; width of pelvis, 4 feet 10 inches; length of femur, 4 feet 1¼ inches. The three most striking characters are:

1. Tusks completely incurved and crossed, thus of little use as tools or weapons.
2. Head small in proportion to the great size of the tusks.
3. Back and body short in contrast with the great height and the length of the limbs.

The Northern or Hairy Mammoth (*E. primigenius*) is the best

known of all the extinct proboscidians. This is due to the fact that several specimens have been found in the permanently frozen ground of the far north in a state of more or less preservation, including flesh, skin, pelage and stomach contents. This animal was closely related to the modern Indian elephant and did not often exceed it in size, but was a little more highly specialized as to molar teeth. The tusks were often very long, spirally and outwardly curved. It was widely spread and numerous over northern Europe, Siberia and northern North America during the Pleistocene and came down to the very end of that period. The mammoth, probably this species, was contemporaneous with early man in Europe, as is clearly shown by the pictures of the animal in the prehistoric caves of France and in a well-known carving on a piece of his own tusk.

In 1799 a specimen was found on the Lena River, Siberia, frozen in the ice and so well preserved that the dogs ate of the flesh, although, as Doctor Lucas thinks, it had been buried from 10,000 to 50,000 years. Unfortunately much of the skin and fleshy parts were destroyed before it was finally retrieved, taken to St. Petersburg and mounted. Its height was 9 feet 4 inches, its length 16 feet 4 inches from the forehead to the tip of the tail, and the tusks, of great size and much curved, measured along the outer or greater curve 9 feet 6 inches. The ears were small, like those of the Asiatic elephant, and the legs slender, as in the African species. It was thickly covered with a dark-brown shaggy coat of three kinds, long stiff bristles and long flexible hairs being mixed with a kind of wool. Another specimen was discovered in 1901 on the banks of the river Berezavka in Siberia, about 800 miles west of Behring Strait and 60 miles within the Arctic Circle. An expedition was dispatched immediately from the Imperial Academy of Sciences, St. Petersburg, and brought back the animal practically entire. The carcass was in a fine state of preservation, some of the flesh looking good enough for human food. The skin and skeleton are now mounted in their museum. The animal had evidently fallen into a crevice and been killed suddenly. Unswallowed food was found on the tongue. The pelvis and right forearm bones were broken.

In the American Museum are the remains of a specimen found on the seashore at Elephant Point, Eschscholtz Bay, Kotzbue Sound, Alaska. The waves had eaten into the resting place of the animal and washed away a large part of it, but the lower jaw, the tusks, a few of the vertebræ, the pelvis and hind limbs, and numerous confused portions of hair, skin, flesh and fat remained. The remains were probably several thousand years old, preserved unchanged in the permanently frozen soil. The animal was a young adult female.

The tusks and molar teeth are well preserved. In a glass case near by are displayed some specimens of chewed grass found in the frozen mud near the lower jaw; also in the same case several bunches of hair, some of it 12 to 15 inches long, of a dark reddish-brown color; and some specimens of the flesh preserved. There is, too, a section cut from the thigh bone showing the central cavity, still filled with the marrow, hardened and rancid, but otherwise little altered.

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ANNOUNCEMENTS

THE courses in Botany, Inorganic and Organic Chemistry, and Museum Talks were completed according to schedule, with satisfactory attendance. The course on Engineering continues until the close of the year. The attendance on this course is specially noticeable from the large proportion of students, some of whom come from considerable distances.

The courses in Zoology, Physics and Geology will begin in January, as stated in the Annual Announcement.

Several extra lectures have been given, the response to which has been very gratifying. Special notice of these is made on the next page.

The alterations and repairs recently made to the building have added much to the comfort, safety, and convenience of the many persons who use its facilities.

Full information of the activities of the Institute may be obtained by personal inquiry or by mail at the office.

Entered as second-class matter, September 10, 1926, at the Post Office, Philadelphia, Pa., under Act of August 24, 1912.

WAG'

SPECIAL INSTITUTE ACTIVITIES

In addition to the regular courses of instruction, the Institute has established a series of special lectures on subjects of general scientific interest. During the fall session the following have been delivered:

October 24, "The Charm of Gardens in Picture and Verse," by Mr. J. V. Hare. This lecture was illustrated by pictures of gardens and garden features. Many of the views were introduced in connection with quotations from standard literature, thus constituting an interesting artistic entertainment.

November 17, "The Romance of the Sea," by Mr. George H. Streaker. This was a comprehensive account of the development of the ship from earliest known periods to the modern battleship. The many forms that ships have exhibited during the ages were shown on the screen.

December 1 and December 8, "The Chemical Controllers of the Human Body," by Dr. Norman M. Grier, Professor of Biology, Elizabethtown College, Elizabethtown, Pa. These lectures consisted of a review of present-day knowledge of the nature and actions of the so-called "endocrine" or "ductless" glands, which have important influence on several phases of personality, a fact which has acquired much importance in medicine and psychology.

All the lectures were well attended. Lectures of similar character will be arranged for the spring session, of which due announcement will be made. Arrangements are also being made for the formal course of lectures under the Westbrook Foundation.

GOLD LEAF—OLD AND NEW

IVOR GRIFFITH, PH.M.

Chemist, Research Laboratory, John B. Stetson Co.

Four thousand years ago the Egyptians hammered gold in much the same way that it is beaten to-day, except that they did not produce nearly so thin a leaf. Their mummy cases, and in some instances the mummies, were profusely gilt. The gold of Egypt was mined, and it is recorded that, in the time of Rameses II, upwards of $35,000,000 worth was the annual yield.

"The temple of Solomon was marvelously gilt"—and in one of his works Pliny mentions that "in my home a single ounce of gold admits of being beaten out into 750 leaves four fingers in length by the same in breadth." Thus it is seen that the beating of gold is by no means a modern art. However, it is fair to presume that the gold leaf of the ancients was of far different character from the tenuous product of this day. The instruments wherewith these artisans worked could not have been nearly so delicate as the tools used by the modern workman in that field. While the Parisian makers in 1621 extended one ounce of gold to cover 105 square feet, the present advanced state of the art extends one ounce to cover 200 square feet, or enough to cover the floor of the average sized living-room.

So that the reader may have a picture of the processes involved in manufacturing gold leaf, the following information, culled from a booklet, issued by Hastings and Company, pioneer American manufacturers of this product, is submitted as being interesting and accurate.

The starting point in gold leaf manufacture is gold bars from the U. S. Mint, 999.9 fine—alloyed with silver and copper, according to the shade desired, the highest grade and standard color being known as XX, or extra deep. This represents a product 23 carats fine.

A long narrow bar 12 x 1 x 1½ inches is cast and rolled into a thin ribbon about 525 feet long. After cutting this into one-inch squares, the gold beater takes 150 pieces of the gold, which are interleaved with as many parchment paper leaves (imported from Europe) four inches square, forming a packet called the "cutch." All packets are held together with parchment bands. The cutch is beaten for twenty minutes with a heavy hammer on a smooth marble block until the gold has thinned and extended to the edges. It is then taken from the cutch and each piece is quartered; the 150 pieces have thus become 600 pieces, and these are interleaved with 600

pieces of gold-beater's skin, forming a packet called the "shoder," which is four and one-half inches square.

The gold-beater's skin mentioned is made from a very delicate membrane lining the intestines of the ox, the preparation of these skins being almost wholly in the hands of one firm in London that supplies the demand of every country where gold leaf is produced.

Another beating then takes place, more careful, more delicate and more precise than the former, until the gold has expanded as far as the shoder will admit. This second beating takes about two hours. Each piece is again quartered, the 600 pieces becoming 2,400 pieces. These are again interleaved with gold-beater's skin and form three packets, each containing 800 pieces, called the "mould," which is $5\frac{1}{4}$ inches square. The leaf is now so thin and delicate that much greater care and thought must be used. Even a change in the weather may now affect it, so the beater has to use all his knowledge to keep it from breaking up or going into holes. This third beating takes four or five hours.

How the workman manages to beat all the pieces equally and yet beat none into holes he alone can answer. It is one of the mysteries of the craft. The finished leaf of gold is about $\frac{1}{280000}$ of an inch in thickness, or, to state it more clearly, five dollars in gold is beaten to cover 6,000 square inches.

The cutters then trim the uneven edges from the leaves with a sharpened reed set in a tool named a "wagon." Twenty-five gold leaves are placed in a book of tissue paper, the leaves of which have been covered with rouge to prevent the thin leaves of gold adhering to the paper. This finishes the process. So delicate is the work of cutting, in the process of which the breath is used more than the touch, that only about 80 per cent. of the beaten leaves are available for putting in the books, the trimmings being remelted.

So thin are the finished leaves that over a quarter million of them, piled one over the other, will occupy a space somewhat short of an inch.

The Control Laboratory of the John B. Stetson Company recently undertook a survey of Gold Leaf supplied to the high-class hat trade for stamping the dies or trade marks on hat leathers. That of American manufacture was vastly superior, from the standpoint of uniformity of color and texture, to the products of foreign origin. From the latter source there has recently come a leaf manufactured by a secret process and said to be available to the trade at a price less than that of the domestic hand and machine worked article.

Practical tests were made with the "new" foreign leaf and were not satisfactory. Uneven texture and color and silver spots

occurred with its use. Photomicrographs were taken of the leaf, which clearly demonstrated its nature. The reproductions shown herewith indicate the fibrous nature of the hand-beaten product and the crystalline structure of the foreign leaf. The inference is, of course, that the latter is an electrolytically deposited leaf. This, no doubt, accounts for the uneven distribution of the gold and the baser metals in the leaf, and the unsatisfactory results obtained with the practical tests.

AMERICAN LEAF. × 800

FOREIGN LEAF. × 800

The following data are from the files in the Research Laboratories of the John B. Stetson Company, and are indicative of the character of the leaf called for by the hat trade. The assays are done in the standard way—the gold by cupellation, the silver by acid solution, etc., and it has been clearly demonstrated that such assays can be conducted with an average error of less than $\frac{1}{10}$ of 1 per cent. All weighings are made with the completely dried product (leaf dried by chemical desiccation).

Weights given in "grams." Measurements given in "inches."

	A	B	C	D
Sheet size (average)	$3\frac{29}{32} \times 5\frac{3}{32}$	$3\frac{7}{8} \times 3\frac{3}{8}$	$3\frac{3}{8} \times 4\frac{1}{2}$	variable
Weight of book	.4645	.4718	.4155	.3892
Number of sheets	25	25	25	25
Average wt. per sheet	.01858	.01887	.01662	
Average wt. per sq. inch	.00093	.00144	.00109	.001199
Fine gold	765	791	759	834
Fine silver	210	190	218	74
Base metals	25	19	23	92
Number of sheets to inch	301,360	194,631	257,128	252,000

A is the product of an American concern, favorably known to the trade. This firm, by scientific control, delivers a very uniform product, with leaf beaten thin, to the very limit of its "beatability," and the gold content always held to its accurate minimum. It is to

be noted that an over-thin leaf has poor covering quality and frequently requires a second leaf to hide its deficiencies. This is not an economical procedure, and practical experience proves the value of a leaf, unpatched, and having a thickness over $\frac{1}{280000}$ of an inch.

B is the product of an American concern using older methods of manufacture and control. This firm is unwittingly generous with its gold, but supplies a very substantial leaf.

C is an American product of fairly uniform quality with no more gold than is demanded, but with a leaf of good texture.

D is the foreign electrolytic product, not satisfactory to the trade. Note the high gold content. This deviation, of course, causes a difference in color compared to the standard product.

The method of calculating thickness of gold leaf is appended herewith, and while it may not be scientifically exact, it has been found quite reliable in practice.

1 cubic inch of water weighs 16.39 gm.

1 cubic inch of gold leaf alloy weighs 280.269 gm.

This figure is obtained after ascertaining the specific gravity of the alloy, used in 760 fine gold. (760 parts per 1000.) This is 17.10. Then 16.39 × 17.10 equals 280.269 gm.

1 square inch of leaf weighs .00103 gm.

Thickness of each leaf is its cubic content divided by its square content.

Proportionally stated 280.27 : .00103 : : 1 cu. inch : x.

x = .000003675 cu. inch (in one square inch of gold leaf).

Therefore its thickness in inches is—

.000003675 ÷ 1 × 1 or 1

or .000003675 of a linear inch.

To make a pile of leaf an inch thick it will require 272,109 sheets or leaves (each .000003675 in. thick).

This calculation may be simplified for practical application by accepting this premise.

If the alloy is approximately 760 parts fine gold, a leaf which will weigh 1 mgm. per sq. inch will require for an inch thickness as many sheets as there are milligrams in each cubic inch of the gold.

Thus if the gold calculates a cubic inch weight of 280.269 gm., and a square inch of its beaten leaf weighs exactly .001 gm. or 1 mgm., there will be exactly 280,269 leaves to the inch. From this we generalize the following theorem:

Number of leaves to the inch = X
Weight of one cubic inch of the gold in milligrams = Y
Weight of one square inch of the leaf in milligrams = Z

Then: X = Y + Z

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of the

WAGNER FREE INSTITUTE OF SCIENCE OF PHILADELPHIA

PUBLISHED BY THE INSTITUTE

Edited by the Publication Committee

HENRY LEFFMANN   SAMUEL TOBIAS WAGNER

Vol. 4 Nos. 1 and 2	Bi-Monthly February–April, 1929	$1.00 per year Single numbers, 20 cents

ANNOUNCEMENTS

THE regular courses on Zoology, Physics and Geology and Museum Talks began according to schedule with satisfactory attendance.

The lectures for 1929 under the Westbrook Foundation will be delivered by Dr. William B. Scott, of Princeton University, on "Volcanoes and Vulcanism." Four lectures will be given on Saturdays, March 2, 9, 16, 23.

Dr. Scott was for many years Professor of Geology and Paleontology in the Institute and is now a member of the Honorary Faculty.

Papers in the hands of the Publications Committee embodying special researches will be issued in the course of the year. Among recent additions to the Museum is a collection of over 100 plants from the regions bordering on the western Mediterranean, collected and presented by Dr. John W. Harshberger.

Entered as second-class matter, September 10, 1926, at the Post Office, Philadelphia, Pa., under Act of August 24, 1912.

RICHARD B. WESTBROOK FREE LECTURE FOUNDATION, 1929

VOLCANOES AND VULCANISM

WILLIAM B. SCOTT, A.M., PH.D., LL.D.
Princeton University

Hall of the Wagner Free Institute of Science, Saturday, March 2, 9, 16, 23 at 8.15 P.M.

LECTURE I

INTERNAL CONSTITUTION OF THE EARTH

Its density, rigidity, elasticity, and temperature. Earth tides.

Subterranean and solar energy. Former is ultimate cause of all earthquakes, volcanoes, rising and sinking of land, hot springs, etc.

Definition of volcanoes: their geographical distribution on continents and islands. Volcanic belts. Distinction between dormant and extinct volcanoes. Vesuvius, Lassen's Peak, Santa Maria in Guatemala.

LECTURE II

PHENOMENA OF VOLCANIC ERUPTION

Extreme difference between different types.

1. Explosive type: Bandai San; Temboro; first recorded eruption of Vesuvius.
2. Quiet eruption: Kilauea; Mauna Loa; Crater Lake.
3. Mixed types: Most modern volcanoes, Stromboli.
4. Fissure eruptions: Skaptar Jokul; N.W. lava fields; basaltic plateaus of India and East Africa.

LECTURE III

FORMER EXTENSION OF VOLCANIC ACTIVITY

Almost universal in pre-Cambrian rocks. Ireland, Scotland, France, Hungary, Italy. New England, New Jersey, Arizona, Utah, New Mexico, etc.

Volcanic products, lava flows; scoriae; bombs; ash and tuff; mud-flows. Volcanic cones; lava-cones; cinder-cones; mixed types. Ancient and eroded cones; volcanic necks.

Submarine volcanoes and volcanic islands. New volcanoes formed in historic times: Monte Nuovo, Jorullo, Isalco, Graham Island.

LECTURE IV

PLUTONIC ROCKS AND CAUSES OF VOLCANIC ACTION

Plutonic rocks; dikes; sills and sheets; stocks; bathyliths. Relation of plutonic to volcanic rocks; how they may be distinguished.

Causes of volcanic action. Things to be explained: (1) Distribution, past and present; (2) High temperatures; (3) Ascensive force of magmas; and (4) Origin of vapors and gases.

Theories of volcanic action. Observations of Day and Jaggar at Kilauea.

[BULLETIN, WAGNER FREE INSTITUTE OF SCIENCE, 1929, 4, 1]

A STUDY OF THE PENSAUKEN FORMATION

LESTER W. STROCK, B.S.
Assistant in Mineralogy, Academy of Natural Sciences of Philadelphia

[The deep excavation along the line of Filbert St., Philadelphia, for the construction of the Pennsylvania R. R. Subway, afforded excellent and unusual opportunities for studying the recent geologic history of the Philadelphia district. By the courtesy of the engineer-in-charge, ample facilities for examining the exposed strata were accorded to me, and the following article is a statement of the result. I desire to express thanks to the engineer-in-charge for the permission to visit the excavation and to take samples. Thanks are also extended to the Academy of Natural Sciences for facilities granted to me to carry on the work with advice and assistance from the department of Mineralogy, especially the aid of Mr. Samuel G. Gordon, Associate Curator of the Department. I am also indebted to the Wagner Free Institute of Science for aid in the work.

From the data obtained a model of the topography of the Philadelphia district in Pensauken time was constructed and placed in the Museum of the Academy of Natural Sciences.]

Since this study deals almost entirely with the Pensauken formation, it will be necessary to point out its exact position in the general scheme of geologic classification. A glance at a textbook will serve:[1] "On the coastal plain of the Atlantic there is a widespread, but thin body of sand, loam and clay, referred to the Pleistocene or glacial age. Earlier workers classed all these non-glacial post-tertiary deposits under the general name of Columbia."

The United States Geological Survey referred to in this paper as the "Survey"[2] separated the Columbia and grouped all the representative deposits in this district under the Quaternary, of which the oldest is the Pleistocene. The Survey describes three well pronounced divisions. (1) The Bridgeton (oldest of the Quaternary, not glacial but contemporaneous with Pleistocene time). (2) The Pensauken. (3) The Cape May (youngest deposits, laid down just before the present or even now forming).

SUMMARY OF THE U. S. GEOLOGICAL SURVEY REPORT

A few words of the Survey's report regarding the formation preceding the Pensauken will aid in understanding what is to follow. In Lafayette time, the last of the tertiary period, land movements

developed a topography such that the region directly west and northwest of Philadelphia was elevated more than the eastern region. The relative level of the Philadelphia area and of the coastal plain was elevated much above sea-level; consequently the continental shelf and the coastal plain were considerably above water. The streams were accelerated and became more heavily laden with eroding material in their lower reaches, and could do more cutting work. According to the Survey, the present channels of the Delaware, Schuylkill, and tributary streams were formed at this time. These streams carved their courses across the continental shelf, then well above sea-level, now deep beneath the shore waters. Quaternary time was ushered in (at least locally) by a decided submergence, so that the channel of the Delaware and its adjacent valley was lower than the level of the sea, the sea of course backing in and making "the valley of the Delaware a lowland adjacent to the river." This lowland was filled by river deposition, constituting the early Quaternary or Bridgeton deposits. An elevation occurred and erosion followed due to the streams endeavoring to get down to sea-level.

Regarding the Pensauken, the next period of deposition, the Survey states: "The configuration of the surface beneath the Pensauken formation indicates that above the somewhat narrow and deep valley of the Delaware there was a broad plain along the river after this interval of erosion, and that the level of this plain now ranges from about 50 feet near Swedesboro to more than 70 feet above at Haddonfield."[3] In fact this upward, even, slope continues, until at Trenton it is 120 feet above sea-level, as indicated by the base of the Pensauken there. This plain along the Delaware is believed to have been terminated eastward by a slope or low scarp some 50 feet higher, that ran in a straight line from Swedesboro northeast, parallel with the Delaware, through Woodbury to Haddonfield and on farther north.

The base of the Pensauken is not level, as the floor of the valley or lowland or on whatever surface it was deposited, was not level. In fact, "the valley-plain sloped gently to the river below Camden, while above Camden it retained its high level nearly to the river and then dropped off abruptly."[4]

Concerning the origin of the Pensauken, the Survey, after weighing all the then known evidence for marine deposition occurring in a submerged area, favored the view that it is a fluvatile or stream deposit. The principal argument was that the material was essentially river-borne and shows no sign of wave action.

"On the whole, therefore, if the formation cannot be said to possess characteristics which demonstrate its fluvatile origin, it is yet true that such origin seems, all things considered, to accord best with the facts as now understood. While the Pensauken appears to be chiefly a fluvatile formation there is some reason to believe that subsidence affected the region while it was being deposited."[5]

Analysis of the Survey Data

In attempting to construct a model of the topography upon which the Pensauken was deposited, the favored conclusion of the Survey quoted above was modified. It seems more likely that the Pensauken deposition occurred under water and not on a lowland or in a river-valley by occasional flooding.

According to the detailed measurements of the Survey given in the Philadelphia Folio the base of the Pensauken at Trenton is in some places 120 feet above sea-level. Since at the present time this formation at Trenton is at some points 30 feet thick, the minimum figure would place the surface of the land at Trenton at 150 feet below present level at the beginning of Pensauken time, if all deposition was made under water. As this was a wide body of water in direct connection with the sea, it must have been 30 feet below sea-level.

At Philadelphia, the base of the Pensauken is 70–80 feet lower than the base at Trenton, and as the least depth of the water at Trenton in Pensauken time was 30 feet, it follows that the body of water or marine estuary was at least 100 to 110 feet deep in this district. The Survey, calculating from measurements of a different nature, states that the original thickness in Philadelphia was about 120 feet, a figure that is in complete accord with the depth of the estuary demanded by the model constructed from the modified conclusions.

The valley of the Schuylkill would have been flooded if the Delaware had been and deposition would have occurred there, but inasmuch as the Schuylkill above the Fall-line is at a much higher level than the Delaware below Trenton, the estuary of the former would be correspondingly shallower and deposition not so extensive. This explains also the occurrence of small patches of formation, mapped as Pensauken by the Survey, that lie in a position parallel with the Schuylkill above Norristown and in the Chester Valley.

Therefore a model that retains the pre-Pensauken surface configuration described by the Survey, and in addition depicts a sub-

was from a pegmatite dike. Many pebbles having the shape of glacial pebbles were found, but none showing any actual glacial scratches.

The formation overlying the above described section is a very fine heavy plastic yellowish-blue clay. It is a typical clay up to a depth of about four feet and for a thickness of twelve feet, where the formation consists of about four feet dry sand and small pebbles occurring in bands which become coarser toward the top.

The clay section is commonly known as the Phila. Blue Clay, and

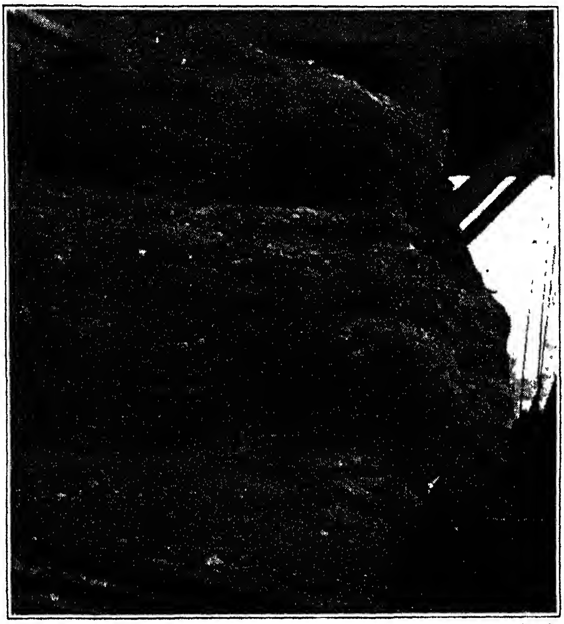
Photograph by Samuel G. Gordon

Contact between blue clay and complex bed (Eighteenth Street). Arrows show point of contact at 16 feet, complex bed below; blue clay above.

has yielded upon analysis insignificant amounts of gold.[8] On exposure it becomes buff. This overlying clay seems to be the most constant characteristic of the Pensauken, when considered over a large area, and appears to indicate that the streams flowing into the estuary were not heavily laden with coarse material but carried finer sediment. All its heavier load as quartz-sand and pebbles, was dropped farther upstream due to a check in velocity as it flowed into a body of water that was becoming steadily shallower, due to deposition. The lower contact of this clay is sharp and level over the entire Filbert St. opening. A deep body of water at some dis-

tance from the mouth of the river would also account for the clay, but the former suggestion seems preferable.

M. F. J. Keeley, studying the diatoms of the Pensauken from a boring just north of Camden, N. J., found that the forms were all marine from the lowest level; passing to higher levels fresh water forms increased in proportion; and at the upper horizon fresh water forms alone were present.[1] The diatoms found in Filbert St. were all fresh water forms, but only the top clay was examined and this not very extensively. A great variation in the flora of Diatomaceæ



Photograph by Samuel G. Gordon

Distinct cross-bedding in complex bed, between depths of 16–22 feet. (Seventeenth Street.)

is found in the Phila., area; in some places the flora is dominantly marine,[8,9] at other places fresh water. Differences are also found at the same localities at different depths.

Overlying the Pensauken are the thin edges of the Cape May Formation.

It appears that the beginning of Pensauken time, the Delaware was a drowned river valley or a marine estuary, from Haddonfield on the east to a corresponding elevation on the plateau west of

Philadelphia. As the estuary was aggraded by deposits from the rivers, aided by a fluctuating, but gradual elevation, a shallow fresh-water bay was formed and subsequently elevated 150 feet and then eroded to form the present topography.

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HENRY LEFFMANN SAMUEL TOBIAS WAGNER

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ANNOUNCEMENTS

THE educational work of the Institute for the season of 1928–9 was entirely satisfactory both as to attendance and attention. At the closing exercises on Wednesday, May 15, nine full course certificates were awarded and sixty-two term certificates. Details of these awards will be published in the August issue of the Bulletin.

At the closing exercises, a brief address was made by Professor Schmucker, President of the Faculty, and the names of those receiving certificates read, after which Professor Schmucker introduced Dr. Donald B. MacMillan, Commander of the MacMillan Arctic Expedition, who delivered a highly interesting and instructive illustrated lecture on his Arctic experiences, entitled "Under the Northern Lights." The attendance was the largest in the history of the Institute.

Full information as to the courses for 1929–30 will be given in the August issue.

Entered as second-class matter, September 10, 1926, at the Post Office, Philadelphia, Pa., under Act of August 24, 1912.

INSTITUTE NEWS AND NOTES

The Course of Lectures under the Westbrook Foundation, delivered by Dr. Scott, of Princeton University, and also Honorary Professor of Geology in the Institute, on "Volcanoes and Vulcanism," was eminently successful both as to attendance and scientific import. The Committee on Instruction is arranging for the Westbrook course for 1930, also extra lectures on subjects within the scope of the Institute. Several such extra lectures were delivered during the session just closed.

It has been decided to discontinue the title "Transactions" heretofore used to designate special papers issued by the Institute and to assign to these the term "Publications." The first volume of the new series has just been issued, designated as Volume I, and is

"A Revision of the Ostracod Genus *Kirkbya* and Subgenus *Amphissites*," by Robert Roth.

During the summer comprehensive repairs will be made to the building, especially by revising the lighting and other conditions in the lecture room.

The vacancy caused by the death of Professor Sydney T. Skidmore has been filled by the election of Dr. Wm. Otis Sawtelle.

For the first time since its appearance in the country the Japanese beetle invaded the Institute grounds last summer in great numbers. By means of spraying and the use of the trap damage was materially limited, but some parts of the lawn were injured by the insect in its subsoil stage.

For all information as to the Institute's activities address the office.

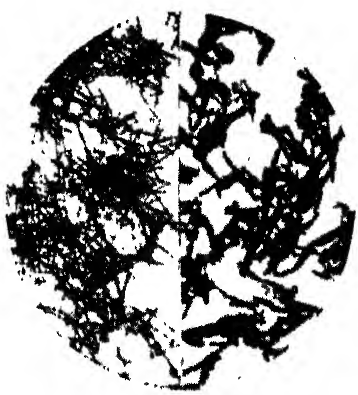
NOTES ON A PRECIPITANT FOR ALDEHYDES

HENRY LEFFMANN and CHARLES C. PINES

Many tests have been devised for the detection of aldehydes, especially for formaldehyde and acetaldehyde. The former is liable to be used as a food preservative, and being produced in most of the tests for methanol in common alcohol, its definite detection in small amount is important. Acetaldehyde not infrequently occurs in distilled spirits, especially those manufactured surreptitiously, commonly called "moonshine." Some years ago Doran and Beyer, chemists of the U. S. Internal Revenue Department, reported analyses of many thousands of samples of confiscated spirits, in some of which appreciable amounts of acetaldehyde were found. There is, however, no evidence as yet that in any of these samples the substance was present in amount sufficient to do harm to users; the alcohol was far more objectionable.

Many of the tests for aldehydes give similar results with ketones, and tests have been sought free from this confusion. W. Stepp presented such a test in a short article in *Zeitsch. Physiolog. Chem.*, 1921, **114**, 301, which he recommended strongly for the detection of acetaldehyde in urine, since it does not give any result with acetone often present in that excretion. The reagent is dimethyldihydroresorcinol, but usually the second "di" is omitted. Stepp abbreviates the name to the arbitrary word "dimedon." Its empirical formula is $C_8H_{12}O_2$. The sample used in the tests here noted was obtained from the Eastman Company and Mr. S. Pethick of the laboratories kindly informed me that the compound is tautomeric, passing easily from the keto to the enol form and the reverse. It is a colorless, minutely crystalline powder, soluble in water, methanol, ethanol, iso-propol, and doubtless many other liquids of their class. Crystalline precipitates are produced with many aldehydes, but except as to brief trials with vanillin, ethylvanillin and salicyl aldehyde, the work has been limited to formaldehyde and acetaldehyde. These respond with entire satisfaction to the test even in small amount. Stepp recommends a solution of the reagent in alcohol, but water seems to serve quite well; methanol is also satisfactory. As a methanol of high purity, acetone-free and almost absolute, can now be obtained readily and at reasonable price, results with it will be studied

later. The crystals produced by formaldehyde are always fine needle-like forms; those from acetaldehyde are usually larger and prismatic, often crossed as "X's," but in a few cases forms closely simulating those of the formaldehyde compound have been produced. Stepp states that the reaction is that the oxygen atom of the aldehyde unites with an additive hydrogen atom from each of two molecules of the reagent, the residues forming the compound that precipitates. He gives its systematic name as "ethylidin-bis-dimethylresorcinol, but suggests substituting for this the word "aldimedon." Obviously some modification of the latter term would be required for each aldehyde. Stepp's experiments seem to have been limited to acetaldehyde, as he was dealing with the clinical aspect of the problem. Owing to the fact that acetaldehyde forms much larger crystals as a rule than formaldehyde, a difference of magnification was used in making photographs. The attached photogravure shows the contrasting forms of the precipitates.



Precipitates by Dimethylhydroresorcinol.

Formaldehyde (left), ×40; acetaldehyde (right), ×20. For explanation of difference in magnification see text.

CALENDAR REFORM

That enigmatical being, primitive man, about whom so much is said and so little known, must have early noticed the changing seasons and their regular recurrence. Originating, as we have good reason to believe, in the northern hemisphere, he felt the cold of winter and heat of summer. In the colder season he noted the sun's failing power, setting earlier each day and rising later, and feared that the source of his life and comfort was dying. After a brief period of uniformity, the glorious orb began to recover its power, and this was celebrated by a festival that persists but with different interpretations in modern life. Exhibiting itself as the Roman Saturnalia, the winter solstice now finds recognition as Christmas and the Feast of Lights. The phenomenon of seasonal recurrence must have early led to a chronology, just as the succession of day and night led to a horology. Accordingly we find efforts at a determination of the length of the year and subdivisions of it in many forms at early times. It is said that the Maya calendar, the details of which have been recently elucidated, is of a high type well adapted for practical purposes.

The calendar in use by the principal civilized nations is partly based upon Christian influence, but is in the main inherited from the Romans. Caius Julius Cæsar, probably the greatest man that ever trod earth's spaces, gave to the Roman world a definite system, and Europe inherited this together with many other Roman influences in literature, art, philosophy, law and religion. Cæsar was supreme and his calendar was at once adopted. Though based on scientific investigation, the Julian calendar was slightly inaccurate, and in the course of centuries, the coincidence of dates and seasons became seriously dislocated. It is probable that if Gregory XIII had not taken up the question in earnest the world might be worrying along with several systems, because a little over half a century before his day the western church had been deeply split by the schism known to Protestant historians as the Reformation and to Roman Catholic historians as the Lutheran heresy. The authority of Gregory was supreme over the nations which were of his faith, but Protestant nations declined the offer to reform and for many years persisted in the use of the Julian calendar. We need not hesitate as to the cause that led ultimately to the adoption of the Gregorian calendar by the dissenting nations of western Europe, and of late

years to its adoption by several nations adhering to the Greek Church. Economic influences, the principle that "Business is business," have been the impelling force. Obviously, the fixing of the duration of the year and the establishment of the intercalary day have nothing to do with the era under which we now count the years. Some interest has lately been taken in a further reform to simplify details and secure greater uniformity in the subdivision. Mr. George Eastman of "Kodak" fame has lately been advocating a system, suggested by Mr. Moses Cotesworth, that provides a year of thirteen months of four weeks each, with the usual extra day every four years. This extra day is not to be counted in the week in which it occurs. It will be a sort of legal "no day," presumably the New Year holiday. This system will bring all important dates on the same day of the week each year. It is proposed by some that all holidays shall be assigned to Monday, without special adherence to the exact date of the old calendar. Thus Independence Day would be celebrated on July 2. It is extremely unlikely that Americans will give up the "glorious fourth," though July 2 is the day that should be celebrated, for it was on that date in 1776 that the resolution for independence was passed. John Adams' advice as to how the action should be commemorated related only to July 2. The assignment of all holidays to Monday will meet with strong opposition from the owners of summer amusement places, who find that when a secular holiday comes close to Sunday the week falls off in receipts, as the patrons at large cannot afford two immediately succeeding "off" days. A minor reform for which there is a widespread hope is the fixing of a definite date for Easter. There is surely no good reason for the shifting now in vogue, but all the resources of religious conservatism will be brought to bear against even this simple and advisable change. The only radical calendar reform of modern times is that of the French revolution. Arranged in part by a man of romantic temperament, it has a strong romantic flavor. There were 12 months of 30 days each. This left five days out in ordinary years. These were officially known as "les jours complementaires" but were dubbed by the irreverent populace "les jours sans culottes," "the days without trousers."

There seems at the present time no likelihood of any appreciable modification of the calendar. A reform could be made by all who wished some simplification by dropping entirely the division into months, dating each day by its succession in the year. In almost all our affairs it is the day of the week and not that of the month that usually concerns us. We wish to know if it is Monday or Thursday, not whether it is the 2nd or 5th of June.

PUBLICATIONS OF THE INSTITUTE

TRANSACTIONS

Vol. 1.—Explorations on the West Coast of Florida and in the Okeechobee Wilderness. *Angelo Heilprin.* $2.50

Vol. 2.—Report on Fresh-water Sponges Collected in Florida. *Edward Potts.*
Notice of Some Fossil Human Bones. *Joseph Leidy.*
Description of Mammalian Remains from Rock Crevice in Florida. *Joseph Leidy.*
Description of Vertebrate Remains from Peace Creek, Florida. *Joseph Leidy.*
Notice of Some Mammalian Remains from Salt Mine of Petite Anse, Louisiana. *Joseph Leidy.*
On Platygonus, an Extinct Genus Allied to the Peccaries. *Joseph Leidy.*
Remarks on the Nature of Organic Species. *Joseph Leidy.* $1.00

Vol. 3.—Parts 1, 2, 3, 4, 5, 6.—Contributions to the Tertiary Fauna of Florida. *William H. Dall.* $15.75

Vol. 4.—Fossil Vertebrates from the Alachua Clays, Florida. *Joseph Leidy.* $1.25

Vol. 5.—Study of Hawaiian Skulls. *Harrison Allen.*
Notes on the Palæontological Publications of Prof. William Wagner. *William H. Dall.* $1.00

Vol. 6.—Selenodont Artiodactyls of the Uinta Eocene. *William B. Scott.* $1.00

Vol. 7.—Contributions to the Mineralogy of the Newark Group in Pennsylvania. *Edgar T. Wherry.*
A Comparative Study of the Radio-Active Minerals in the Collection of the Wagner Free Institute of Science. *Carl Boyer and Edgar T. Wherry.* $0.50
Vegetation of South Florida. *John W. Harshberger.* $2.50
Studies in Carbohydrates. *Charles H. LaWall and Sara S. Graves.* $0.50

Vol. 8.—Special Lectures by the Teaching Staff of the Institute. $2.00

Vol. 9.—Part 1.—The Vegetation of the Hackensack Marsh: A Typical American Fen. *John W. Harshberger and Vincent G. Burns.* $1.00
Part 2.—On the Life History of an Economic Cuttlefish of Japan; Ommastrophes sloani pacificus. *Madoka Sasaki.* $1.00

Vol. 10.—Contributions by the Faculty of the Institute. Post-fixation Development. *H. Leffmann.* Reconstruction of Columbia Bridge. *S. T. Wagner.* Origin and Relationship of North American Song Birds. *S. Trotter.* The Three-Electrode Bulb in Radio Signals. *L. B. Seely.* Detection of Methanol in Presence of Ethanol. *C. H. LaWall.* Chemical Attraction. *D. W. Horn.* $2.00

Vol. 11.—Biochemistry of American Pitcher Plants. *Joseph S. Hepburn, Elisabeth Q. St. John and Frank M. Jones.* $2.50

PUBLICATIONS

Vol. 1.—A Revision of the Ostracod Genus *Kirkbya* and Subgenus *Amphissites.* *Robert Roth.* $1.00

Bulletin of the Institute. Bimonthly $1.00 per year
Single numbers, 20 cents.

WAGNER FREE INSTITUTE OF SCIENCE

Montgomery Ave. and Seventeenth St., Philadelphia, Pa., U. S. A.

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George F. Stradling, Ph.D.	Physics
Samuel T. Wagner, B.S., C.E.	Engineering
Spencer Trotter, M.D.	Zoology

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Department of Biology
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Benjamin F. Howell, A.M., Ph.D.

Carl Boyer, *Director*

BULLETIN

OF THE

WAGNER FREE INSTITUTE OF SCIENCE

OF

PHILADELPHIA

VOLUME IV, NO. 4, AUGUST, 1929

ANNOUNCEMENT

FOR

SESSION OF 1929-30

EIGHTY-SECOND YEAR

WAGNER FREE INSTITUTE OF SCIENCE OF PHILADELPHIA

SEVENTEENTH STREET AND MONTGOMERY AVENUE

PHILADELPHIA, PA., U. S. A.

Entered as second-class matter, September 10, 1927, at the Post Office, Philadelphia, Pa., under Act of August 24, 1912.

LECTURES UNDER RICHARD B. WESTBROOK FOUNDATION

1912.—Ancient Civilization of Babylonia and Assyria. *Morris Jastrow, Jr., Ph.D.*

1913.—Conservation of Natural Resources.
Gifford Pinchot, Marshall O. Leighton, Overton W. Price, Joseph A. Holmes.

1914.—The Theory of Evolution. *William Berryman Scott, Ph.D., LL.D.*

1915 —Invisible Light. *Robert Williams Wood, LL.D.*

1916 —Aspects of Modern Astronomy *John Anthony Miller, A.B., A.M., Ph.D.*

1917 —Heredity and Evolution in the Simplest Organisms.
H. S. Jennings, B S., A M., Ph.D., LL.D.

1918.—The Chemistry, Nutritive Value and Economy of Foods.
Harvey W. Wiley, A.M., M.D., B S., Ph D., LL.D., D Sc.

1919.—The Origin and Antiquity of the American Indian *Aleš Hrdlička.*

1920.—Chemistry and Civilization. *Allerton S. Cushman, B.S, A.M., Ph D.*

1921.—Microbiology. *Joseph McFarland, M.D., Sc.D.*

1922.—Evolution of the Human Face. *William K. Gregory, Ph.D*

1923.—The Philosophy of Sanitation. *George C. Whipple, B.S.*

1924.—The Distribution of American Indian Traits. *Clark Wissler, A.M., Ph.D.*

1925.—Structural Colors. *Wilder D. Bancroft, Ph.D., Sc.D.*

1926.—The Animal Mind; its sources and evolution. *George Howard Parker, Sc.D.*

1927.—An Interpretation of Atlantic Coast Scenery. *Douglas W. Johnson, Ph.D.*

1928.—The Science of Musical Sounds. *Dayton C. Miller, Ph.D.*

1929.—Volcanoes and Vulcanism. *William B. Scott, Ph.D., LL.D.*

WESTBROOK FREE LECTURESHIP PUBLICATIONS

Can be purchased through any book-store

Ancient Civilization of Babylonia and Assyria, by *Morris Jastrow, Jr.* J. B. Lippincott Co.

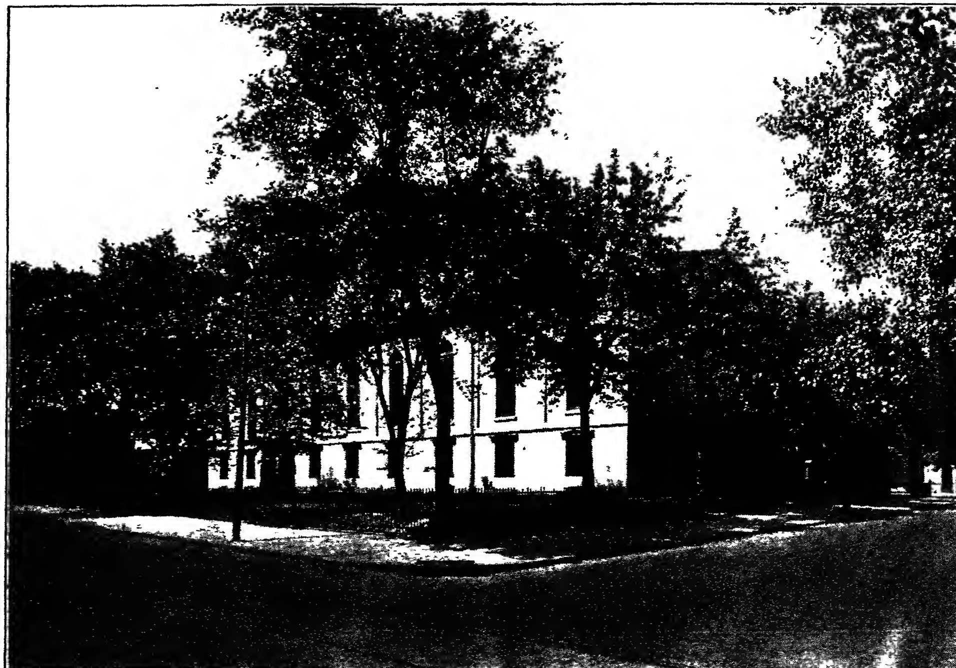
The theory of Evolution, by *William Berryman Scott.* The Macmillan Co.

Life and Death, Heredity and Evolution in Unicellular Organisms, by *H. S. Jennings.* Richard G. Badger.

Chemistry and Civilization, by *Allerton S. Cushman.* Richard G. Badger.

Fighting Foes too Small to See, by *Joseph McFarland.* F. A. Davis Co.

The Relation of Nature to Man in Aboriginal America, by *Clark Wissler.* Oxford University Press.



The Wagner Free Institute of Science
Montgomery Ave. and Seventeenth St.

BULLETIN

of the

WAGNER FREE INSTITUTE OF SCIENCE OF PHILADELPHIA

PUBLISHED BY THE INSTITUTE

Edited by the Publication Committee

HENRY LEFFMANN | SAMUEL TOBIAS WAGNER

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No. 4

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August, 1929

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WAGNER FREE INSTITUTE OF SCIENCE

Montgomery Ave. and Seventeenth St., Philadelphia, Pa., U. S. A.

HISTORICAL NOTE

The Wagner Free Institute of Science owes its establishment to the liberality and public spirit of William Wagner and his wife, Louisa Binney Wagner. In his early life Professor Wagner made extensive voyages in the service of Stephen Girard, and had opportunities to visit scientific institutions and make the acquaintance of scientific workers. He soon developed a strong interest in the natural sciences, especially geology and mineralogy, and devoted a large part of his life to studying these topics and collecting material to illustrate the teaching of them.

In 1847 he began to give free lectures at his home, near the present location of the Institute building, at that time in the rural section of the county. In 1855 the Institute was incorporated by the Legislature, a faculty was appointed and lectures were given at Commissioners' Hall, Thirteenth and Spring Garden Streets, by permission of the city authorities. In a few years the city was obliged, by its own needs, to withdraw the privilege of the hall, and Professor Wagner arranged to erect a suitable building on his own property. This was completed in May, 1865, and lectures at once given in it. In 1864 a deed of trust was executed by Professor Wagner and his wife, furnishing a permanent endowment of the Institute.

In 1885, by the death of the founder, the care of the Institute passed into the hands of a Board of Trustees, since which time many improvements have been made in the building, and extensive additions to the equipment in the museum and library and in scientific apparatus. In 1901 a wing was built for the use of a branch of the Free Library of Philadelphia.

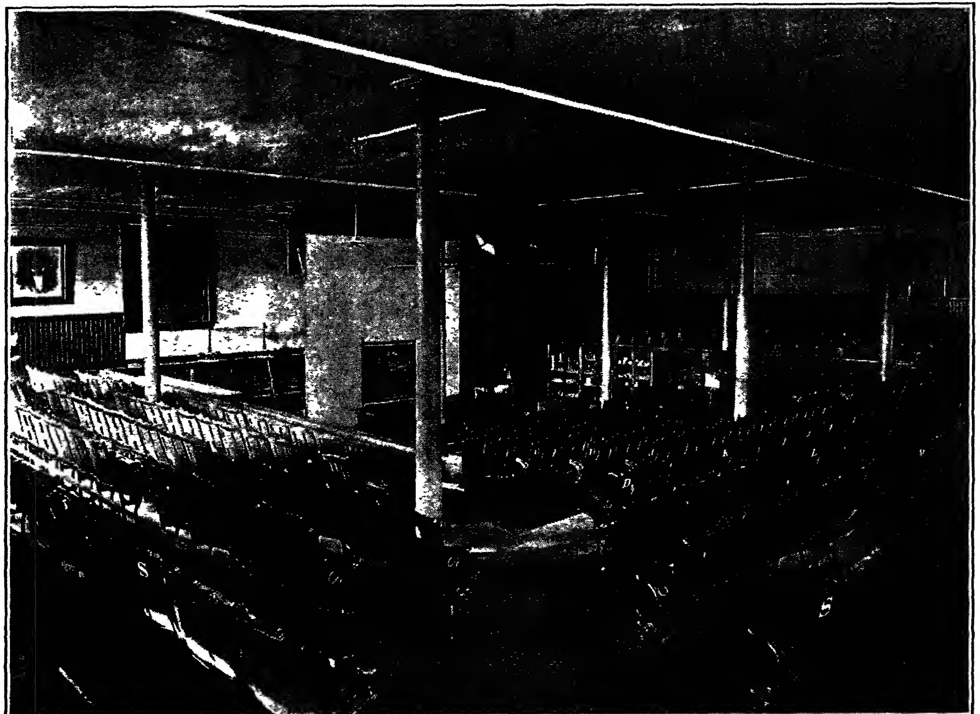
FACILITIES FOR INSTRUCTION

Lectures and Class-Work

Instruction at the Wagner Free Institute of Science is conducted by means of public lectures, supplemented by class-work, and is without charge and without restriction of race or sex. The class-instruction is given partly at the close of each lecture, partly by written exercises. The Museum and Reference Library of the Institute are available for aid in the instruction work and are freely used. In addition, the Wagner Free Institute Branch of the Free Library of Philadelphia affords abundant opportunities for collateral reading.

The lecture-hall is provided with the latest apparatus for lantern-slide and opaque projection, and a motion-picture machine.

At the close of each course of lectures an examination is held, to which those who have attended the classes are admitted, and on



AUDITORIUM

Museum

passing such examination the pupil is awarded a certificate. Certificates are awarded at a public meeting held in May of each year.

The lecture courses are arranged to cover a given topic in four successive years, and to those who hold certificates for each of these courses a full-term certificate is issued.

MUSEUM

The Museum covers the whole field of natural science and contains illustrations in all departments of biology, geology, mineralogy, metallurgy, and engineering. The specimens are arranged so as to be easily studied and are open to inspection from 2 to 5 o'clock Wednesday and Saturday afternoons, except legal holidays.

Teachers with classes and others desiring to use the museum for special studies can, by applying at the office, gain admission any week-day, except holidays, as above stated, between the hours of 9 A. M. and 5 P. M.

The collections of the museum have been used for a number of years for instruction by means of "Museum Talks," as noted below, and by arrangement with work at Temple University and the Division of Science Teaching of the Board of Public Education those teaching General Science in the eighth and ninth grades of the Philadelphia public schools or preparing for such teaching may secure elective credits upon the completion of the work as follows:

General Science II

Monday,	7 P. M. to 8 P. M.	Museum Lecture.
	8 P. M. to 9 P. M.	Lecture Course—Botany and Zoology.

NOTE: Four semester hours of credit will be given for the complete Monday evening program.

Tuesday,	8 P. M. to 9 P. M.	Lecture Course—Inorganic Chemistry and Geology.
Wednesday,	8 P. M. to 9 P. M.	Lecture Course—Organic Chemistry and Physics.

NOTE: An additional two semester hours of credit per evening may be obtained by electing Tuesday or Wednesday evening.

Monday evening is a prerequisite for these, however.

Further information concerning these courses may be obtained at the Office of the Institute.

LIBRARIES

The Reference Library contains text-books and works of reference in all departments of science, encyclopedias, many works devoted to literature, and an assortment of dictionaries of English, classical

and foreign languages. It is open on all regular business days from 9 A. M. to 9 P. M., a librarian being in attendance to assist students.

The Circulating Library is a branch of the Free Library of Philadelphia. It is open every business day from 9 A. M. to 9 P. M. Books may be taken out under the usual rules of the Free Library. Many periodicals—American and foreign, scientific and literary—are on file.

BULLETIN

The BULLETIN of the Institute is bi-monthly. It contains information as to the methods of work of the Institute, announcements of additions to its collections and original contributions to science. The fourth volume is now in course of publication. The subscription price is $1.00 per year, single copies, 20 cents.

SPECIAL LECTURES

By the liberality of Richard Brodhead Westbrook, D.D., for many years a trustee of the Institute, and of his wife, Henrietta Payne Westbrook, provision has been made for lectures independent of the general courses of the Institute and covering a wide range of topics.

A list of lectures so far given and of publications thereof so far issued is printed on back cover page.

Announcement of the course for 1930 will be made in a subsequent issue of the BULLETIN.

The *Philadelphia Natural History Society* meets on the third Thursday of each month, except June, July and August. These meetings are open to all persons interested in the subjects.

RESEARCH

The Institute has carried on research work since 1885, most of the results having been published in its Transactions and Publications. A list of these will be found on the second cover page. Results of research appear also from time to time in the BULLETIN.

The income of a special fund is available for research in chemistry.

CLOSING EXERCISES

In May of each year the courses of instruction are formally closed by a public meeting at which addresses are given and the certificates awarded.

At the closing exercises in May, 1929, after an address by Professor Samuel C. Schmucker, President of the Faculty, and awarding of certificates, Commander Donald B. MacMillan delivered a lecture entitled "Under the Northern Lights."

FULL TERM CERTIFICATES AWARDED

ENGINEERING
Emanuel Hocking

BOTANY
Mrs. Thomas H. Peacock

INORGANIC CHEMISTRY
Milton K. Meyers

ORGANIC CHEMISTRY
Walter F. Estlack

ZOOLOGY
Walter F. Estlack

GEOLOGY
D. B. Johnson
Harold Poole
Carl Wolff

PHYSICS
John J. A. Devine

1928-1929 CERTIFICATES AWARDED

ENGINEERING 2

Robert B. Bowman
Paul O. Emerick
A. W. Fischer
Paul Gehris
William D. S. Gillette
Herman Gruble
Cedric Haring
Emanuel Hocking
Chauncey R. Kay
John J. Kyle
Monroe P. Lesher
Henry O. Lind
Wilfred R. Newton

BOTANY 2

Henry L. Burr
William D. S. Gillette
Harry A. Lloyd
Florence McIlravey
Bertha Mueller
Mrs. Thomas H. Peacock
Henry C. Savage
Ellis E. Stineman
Mrs. W. E. Toner

INORGANIC CHEMISTRY 4

Noah B. Goldsmith
H. L. Grabosky
John G. Hope
Milton K. Meyers
George H. Neuman
Lewis I. Noble

ORGANIC CHEMISTRY 4

Walter F. Estlack
Clive A. Henninger
Ralph Pressman
Louis B. Seiden
Frank J. Sitko
Leon E. Tull

ZOOLOGY 1

Walter F. Estlack
Edward H. Gillette
William D. S. Gillette
Emanuel Hocking
Mrs. Dorothy G. Lloyd
Florence McIlravey
Bertha Mueller
Henry C. Savage

GEOLOGY 2

Noah B. Goldsmith
William Heck
John G. Hope
D. B. Johnson
George H. Neuman
Lewis I. Noble
Harold Poole
Bertha Mueller
Henry C. Savage
Henry Winsor
Carl Wolff

PHYSICS 3

John J. A. Devine
Marguerite N. Dickey
Edward H. Gillette
William D. S. Gillette
H. L. Grabosky
Clive A. Henninger
Mrs. Dorothy G. Lloyd
Henry C. Savage
Henry Winsor

REGULAR LECTURES, SESSION OF 1929–1930

ENGINEERING 3

PROFESSOR WAGNER

Roads, Railroads and Tunnels

Lectures begin at 8 p. m.

1. Friday, September 6.
   Engineering Location. Surveying. Making the Measurements. Measuring Straight Lines. Measuring Angles. Field Work.
2. Friday, September 13.
   Engineering Location. Vertical Measurements. The "Y" Level. Barometer. Field Work. Topography. Contours. Plane-table.
3. Friday, September 20.
   Roads and Streets. Definitions. Reconnaisance. Preliminary Surveys. Maps. Profiles. Location. Points Determining Best Location.
4. Friday, September 27.
   Roads and Streets (Continued). Earthwork. Drainage. Foundations.
5. Friday, October 4.
   Roads and Streets (Continued). Surfacing. Natural Dirt Roads. Gravel Roads. Broken Stone Roads; Macadam.
6. Friday, October 11.
   Roads and Streets (Continued). Telford Roads. Granite Block Streets. Asphalt Streets.
7. Friday, October 18.
   Roads and Streets (Concluded). Wood Pavements. Concrete Pavements. Relative Merits of Pavements. Repairs. Economic Importance. History.
8. Friday, October 25.
   Railroads. Economic Location. Details of Location Estimates. Railroad Curves. Field Work.
9. Friday, November 1.
   Railroads (Continued). Earthwork. Machinery Used. Drainage. Ballast. Ties.
10. Friday, November 8.
    Railroads (Continued). Rails. Frogs. Switches. Crossings.
11. Friday, November 15.
    Railroads (Continued). Signals: Block; Interlocking. Turntables. Snow Sheds and Fences. Rolling Stock and Locomotives.
12. Friday, November 22.
    Railroads (Continued). Cars. Stations. Terminals. Bridges. Elevated Railroads.
13. Friday, November 29.
    Railroads (Concluded). Underground Railroads. Use of Electricity. Street Railways. Rack Railroads.
14. Friday, December 6.
    Tunnels. Location. Where Used. General Principles of Construction.

15. Friday, December 13.
    Tunnels (Continued). Shafts. Headings. Driving in Soft Ground; in Rock. Blasting. Explosives. Ventilation.
16. Friday, December 20.
    Tunnels (Concluded). Cross-sections. Packing. Rate of Progress and Cost. Submarine Tunnels. Shield Method of Driving. Special Examples

INORGANIC CHEMISTRY 1

PROFESSOR HORN

General Principles. Notation. Nomenclature.

Lectures begin at 7.45 P. M.*

1. Tuesday, September 10.
   Scope of Chemical Science. Distinctions between physical and chemical change. Characters of chemical change (color, odor, solubility. Other changes in properties). Necessity for intimate contact for reacting bodies. Velocity of chemical change.
2. Tuesday, September 17.
   Definiteness of Chemical Action. Law of indestructibility of matter. Law of definite proportion. Idea of the elements, and of chemical compounds.
3. Tuesday, September 24.
   Atomic Theory. Law of multiple proportions. Atomic weights. Symbols and their uses. Complexity of the atom. Electrons.
4. Tuesday, October 1.
   Hydrogen. Occurrence, preparation, properties. Use as a standard. Industrial uses.
5. Tuesday, October 8.
   Molecular Theory. Molecular weights. Formulas and their use. Representation of reactions by chemical equations. Complexity of molecules. Isomerism.
6. Tuesday, October 15.
   Oxygen. Occurrence, preparation, properties. Use as a standard. Industrial uses. Ozone. Allotropism.
7. Tuesday, October 22.
   Chemical Forces. Law of chemical statics. Law of chemical kinetics. Historical views of chemical affinity. Chemical resistance. Valence. Transmutation of elements.
8. Tuesday, October 29.
   Water. Composition. Preparation of pure water. Decomposition by metals and non-metals. Hydroxids. Hydrates. Solutions. Importance to life. Heterogeneous equilibria and the phase rule. Hydrogen peroxid.
9. Tuesday, November 5.
   Electro-Chemical Phenomena. The tension series. Equivalence. Faraday's laws of electrolysis. Ionization. Strong and weak electrolytes. Neutralization. Indicators. Hydrolysis.

* Please note the hour.

10. Tuesday, November 12.
    Principal Types of Inorganic Compounds. Oxids. Anhydrids. Salts. Nomenclature. Acid salts and basic salts. Radicles. Double salts, molecular compounds, and complexes.
11. Tuesday, November 19.
    Physical-Chemical Phenomena. Catalysts. Colloids. Osmotic pressure. Active and inactive molecules. Dissociation.
12. Tuesday, November 26.
    Air. History. Composition. Modern ideas of the structure of the atmosphere. The "Noble" gases. Oxidation and reduction. Industrial uses of air. Modern views on ventilation.

ORGANIC CHEMISTRY 1

PROFESSOR GRIFFITH

General Principles: Aliphatic Hydrocarbons and Derivatives

Lectures begin at 8 P. M.

1. Wednesday, September 11.
   Nature and Composition of Organic Substances. Distinctions between the terms organic and inorganic; between organic and organized. 1828—Wohler's discovery of urea synthesis—and changed concepts of organic chemistry. General tests for organic substances.
2. Wednesday, September 18.
   Transformations of Organic Matter in Nature. Fermentation—Putrefaction—Decay. Circulation of the Elements—Nitrogen and Carbon. The "ups and downs" of Nitrogen.
3. Wednesday, September 25.
   Transformations of Organic Matter in the Laboratory. Destructive distillation, fractional distillation, substitution of elements and groups. Organometallic compounds.
4. Wednesday, October 2.
   Industries Based Upon Fermentations of Various Kinds. Alcohol, acetone, glycerol, lactic acid, citric acid. Tanning, Brewing, Food and Dairy Industries.
5. Wednesday, October 9.
   Classification and Nomenclature of Organic Compounds. A study in names. Diaminodihydroxyarsenobenzene hydrochloride. Sodium chloride. John Jones. Complexity of organic terms necessary; each syllable means something to those who "run and read."
6. Wednesday, October 16.
   Molecular Structure. Isomerism, metamerism. Einsteinian chemistry—stereochemistry and optical activity.
7. Wednesday, October 23.
   Hydrocarbons. Principal types. Homologous Series. Paraffins (methanes) Petroleum. Gasolins, cleaning fluids and solvents.
8. Wednesday, October 30.
   Paraffins (methanes) (Continued). Natural gas and its derivatives. Coal gas, bitumens, etc.

9. Wednesday, November 6.
   Olefins (ethenes). Derivatives of hydrocarbons. Alcohol radicles.
10. Wednesday, November 13.
   Alcohols. Grain and wood alcohols, denatured alcohols, medicated alcohols, industrial alcohols. Other alcohols used in the arts and industries. Alcoholic beverages.
11. Wednesday, November 20.
   Ethers and Esters. Scent and flavor owe their favor, mostly to these twins. Esterification, hydrolysis, saponification.
12. Wednesday, November 27.
   Esters (continued) and Aldehydes. Commercial uses of ethers and esters. Industrial solvents. The great lacquer industry. Aldehydes, imitation fruit flavors.

BOTANY 3

PROFESSOR KAISER

Taxonomy

Lectures begin at 8 P. M.

1. Monday, September 9.
   Gramineæ. Cyperaceæ. Grasses and sedges. Culm, leaf, inflorescence and caryopsis. The glume. Vast importance to man of the cereals and pasture grasses. Sugar cane and bamboo. The papyrus of antiquity.
2. Monday, September 16.
   Palmæ. Araceæ. Palms and arums. Spadix and spathe. Cocoanuts and dates. The many uses of palms. Skunk cabbage and its kin. Cella, calamus and golden club. Taro. The gigantic Jack-in-the-pulpit of Sumatra.
3. Monday, September 23.
   Liliaceæ. Amaryllidaceæ. Iridaceæ. Lilies, amaryllids and irids. Trimerous flowers. The bulb. Tulips and hyacinths. Onions and asparagus. Daffodils and crocus. Gladiolus and crocus. The beautiful garden iris and its interesting flower.
4. Monday, September 30.
   Orchidaceæ. Orchids. Gynandrous flowers, most highly specialized to secure insect pollination. Terrestrial species and showy epiphytes of the tropics. Mychorrhiza, in connection with germinating seeds. Infinite variety in complicated development and color.
5. Monday, October 7.
   Betulaceæ. Fagaceæ. Birches and oaks. Monoecious, wind-pollinated trees of our deciduous woodlands, sources of valuable timber. The graceful white, red, yellow and sweet birches. The oak, monarch of the forest, and the many often puzzling forms, often due to hybridism.
6. Monday, October 14.
   Nymphacaceæ. Magnoliaceæ. Ranunculaceæ. Water lilies, magnolias and crow foots. Primitive flowers and their natural groupings. The development of a nectary in plant forms from buttercup to columbine and larkspur. The garden of Louis XV and the work of Antoine Laurent de Jussieu.

7. Monday, October 21.
   Papaveraceæ. Cruciferæ. Poppies and mustards. The story of opium. Derivation of the many forms of cabbage. Plants that afford adornment to our gardens and relishes for our table. Alyssum, arabis and wallflower. Radish, horseradish and watercress. The closely allied caper and bleeding heart.
8. Monday, October 28.
   Rosaceæ. Roses. A family of beauty and usefulness. The queen of flowers and her pedigree. Interesting development of the pome, drupe and drupetum. Apple, pear, quince. Peach, plum, cherry. Blackberry, raspberry, strawberry.
9. Monday, November 4.
   Leguminosæ. Peas, beans and lentils. The evolution of a papilionaceous flower. The unanimity of the fruit, which is a legume. Sensitive plants and logwood. Licorice and groundnut. Trees with brightly-colored flowers of the tropics and a long list of plants useful to man in the arts.
10. Monday, November 11.
    Cornaceæ. Araliaceæ. Umbelliferæ. Dogwoods, ginsengs and parsley. The ornamental cornels. Ginseng and its cultivation. The umbel as an effective inflorescence. The delicious celery. Anise, caraway, coriander and other aromatic plants. Carrots and parsnips.
11. Monday, November 18.
    Solanaceæ. Scrophulariaceæ. Nightshades and figworts. Important families which produce vegetables, poisons and attractive flowers. Potato, tomato, egg plant and sweet peppers. Belladonna, datura and henbane. The remarkable history of tobacco. Foxglove, gerardia, calceolaria and many other plants of greenhouse and garden. The Empress tree.
12. Monday, November 25.
    Compositæ. Asters. The largest family of phanerogams and crown of the vegetable kingdom in successful competition with other plants in the struggle for existence. Structural characteristics effective in obtaining cross pollination and in disseminating the fruits. Chrysanthemum, dahlia, marigold and daisy. Lettuce, endive, artichoke and salsify.

ZOOLOGY 2

PROFESSOR SCHMUCKER

The Backboned Animals

Lectures begin at 8 P. M.

1. Monday, January 6.
   The Beginnings of a Backbone. The acorn-tongued worms. The sea squirts slip back. The lancelets hold over.
2. Monday, January 13.
   The Primitive Fishes. The Lampreys step up. The sharks carry on. The promise of the lung fishes.
3. Monday, January 20.
   Fishes of the Modern Type. Their scaly coat. The skeleton and the muscles The fins and their promise. Rearing their young.

4. Monday, January 27.
   Trying the Land. The salamander takes to the land. The tail disappears in the frog and the toad. Advance in propagation.
5. Monday, February 3.
   The Great Reptile Group. Its dominance in the Age of Reptiles. Its present decadence. The central lizards are modified into snakes, turtles and crocodiles.
6. Monday, February 10.
   The Birds Developed from the Reptiles. An old transition form. Scales turn to feathers. Birds with teeth. Ostriches lose their flight. The modern bird with its warm blood and incubated eggs.
7. Monday, February 17.
   The Great Types of Birds. Water birds: divers, gulls and ducks. Wading birds: snipe and herons. Land birds: pheasants and chickens. Birds of prey: hawks, owls and vultures. Peckers. The song birds: finches and thrushes.
8. Monday, February 24.
   The Milk Giving Animals. The duckmole and its belated eggs. The kangaroo with its nurse pouch. The development of the placenta and the safer young.
9. Monday, March 3.
   The Timid Section of the Milk Givers. The primitive insect eaters. The rodents and their gnawing teeth. The bats take to the air.
10. Monday, March 10.
    The Hoofed Animals Rise on Their Toes. The elephant and his lengthened nose. The cattle and their lost toes. The horses on their single toe. The whales go back to the water.
11. Monday, March 17.
    The Flesh Eating Animals. The flat footed bears. The dog family and the pack habit. The cat that walks by himself. The seals return to the sea.
12. Monday, March 24.
    The Crown of the Kingdom. Hand and brain. The fox-like lemurs. American monkeys and their clinging tails. Old world monkeys whose tails will not hold. The tailless apes. Man crowns them all.

PHYSICS 4

PROFESSOR SEELY

Electricity and Magnetism

Lectures begin at 8 P. M.

1. Wednesday, January 8.
   Static Electricity. Historical Sketch. Nature of Electricity Charges and Currents. Two Kinds of Charges. Law of Electrical Attraction and Repulsion. Static Machines. Potential and Capacity. Condensers. Action of Points. Lightning.

2. Wednesday, January 15.
Electric Cells. The Voltaic Cell. An "Electric" Current. Unit of Electromotive Force, or Pressure. Source of Energy in Voltaic Cell. Local Action. Polarization. Voltaic Batteries. Open and Closed Circuit Cells. Thermoelectric Currents.

3. Wednesday, January 22.
Electrolysis. Electrolytic Conductors. Action in Electrolytic Cells. Laws of Faraday. Chemical Equivalent and Electrochemical Equivalent. Voltameters.

4. Wednesday, January 29.
The Flow in Circuits. Conductivity. Resistance, Pressure and Current Flow. Ohm's Law. Electrical Units. Specific Resistance of Conductors.

5. Wednesday, February 5.
The Flow in Circuits (Continued). Resistance of Wire Circuits. Circuits in Parallel and in Series. Shunts. Fall in Pressure along a Circuit. Connection of Cells in Parallel and in Series.

No lecture February 12.

6. Wednesday, February 19.
The Flow in Circuits (Continued). Heat Effects of the Current. Electrical Work and Power. Conservation of Energy. Relation of Electrical Units to Mechanical Units.

7. Wednesday, February 26.
Magnetism. Historical Sketch. Natural and Artificial Magnets. Two Kinds of Magnetic Poles. Law of Magnetic Attraction and Repulsion. Magnetic Induction. Nature of Magnetism. Magnetic Fields. Terrestrial Magnetism.

8. Wednesday, March 5.
Magnetic Effects of Current. Effect on Magnetic Needle. The Field Produced by a Current. Rules for Determining the direction of the Field. Fields Produced by Coils. Electromagnets. Permeability and Reluctance. The Magnetic Circuit.

9. Wednesday, March 12.
Electromagnetic Induction. Conductor Moving across a Magnetic Field. Early Magneto Machines. Direction and Magnitude of Induced Pressure. Coil in Magnetic Field. Induction Coils. Lentz's Law.

10. Wednesday, March 19.
Measuring Instruments. Galvanometers. Voltmeters and Ammeters. Wattmeter.

11. Wednesday, March 26.
Measurement of Resistances. Measurement by Substitution. Resistance Boxes. Wheatstone's Bridge and its Uses. Volt and Ampere Method of Measuring Resistances.

12. Wednesday, April 2.
Direct Current Dynamos and Motors. Field Magnets. Bi-polar and Multipolar Machines. Armatures. Commutator. Series, Shunt and Compound Windings for Fields.

13. Wednesday, April 9.
Alternating Currents. Representation of A.C. by a Curve. Self Induction. Lag. Impedance.

14. Wednesday, April 16.
    Alternating Currents (Continued). Ohm's Law Applied to A.C. Power Curves. Measuring Instruments for A.C. Use.
15. Wednesday, April 23.
    Principles Underlying Some Common Electrical Instruments. Telephone. Telegraph. Radio. Electric Lamps.
16. Wednesday, April 30.
    Theory of the Electrical Constitution of Matter. The Becquerel Rays. Radium and Its Products. The Molecular Constitution Electricity.

GEOLOGY 3

PROFESSOR HOWELL

Paleontology

Lectures begin at 7.45 P. M.*

1. Tuesday, January 7.
   Paleontology, the Science of Ancient Life. Why it is important that we should know and understand the history of life.
2. Tuesday, January 14.
   Fossils, the Hieroglyphics with which Nature has written the Book of the Dead. How we find the scattered pages of this book.
3. Tuesday, January 21.
   How we Read the Clock of Time. The paleontologists's long years, months, days, and hours.
4. Tuesday, January 28.
   The Ever-flowing Stream of Life. How the study of paleontology unfolds a picture of the endless procession of the life of the Past.
5. Tuesday, February 4.
   How Plants and Animals are Named and Classified. How we modern Adams designate and arrange them in natural groups, so that we may better understand their relationships and more easily refer to them by name.
6. Tuesday, February 11.
   Paleœcology. The relation of the plants and animals of the past to the environments in which they lived. Facies.
7. Tuesday, February 18.
   The Evolution of Life in the Past. The evidence which paleontology presents of the ways in which organisms have changed to adapt themselves to new environments.
8. Tuesday, February 25.
   The Beginnings of Life. The tiny one-celled creatures from which the higher plants and animals have evolved. Bacteria. Algæ. Protozoa.
9. Tuesday, March 4.
   How the Plants Came out on Land. The oldest land plants and their descendants.

* Please note the hour.

10. Tuesday, March 11.
    The Plants of the Great Coal Forests. How they lived and died and were changed into coal.
11. Tuesday, March 18.
    The Rise of the Flowering Plants. The modern, highly evolved, Spermatophytes, and their interesting adaptations to various habitats.
12. Tuesday, March 25.
    The First Many-celled Animals. Nature's different experiments in the development of Metazoans. Archæocyathids, Sponges and Cœlenterates.
13. Tuesday, April 1.
    Mother Nature Decides on a Plan for the Higher Animals. The early worm and his varied descendants.
14. Tuesday, April 8.
    The Creatures Which Never Grew Legs. Echinodermata. Molluscoidea and Mollusca.
15. Tuesday, April 15.
    The Legged Animals. Arthropoda and Chordata.
16. Tuesday, April 22.
    The Paleontology of Man. What we know of the early history of the human race.

SERIES OF MUSEUM TALKS

Monday Evenings at 7 o'clock

Sept. 30. Skins of Animals—Skins of Animals, Their Functions and Uses
Mr. Lawrence
Oct. 7. Great Groups of Plants—Nettle Family..........Professor Kaiser
Oct. 14. Water Birds and Land Birds of Water Habitat—Bird Study: Structure—Color—Feathers—Classification..............Miss Borden
Oct. 21. Skins of Animals—Aquatic Fur Bearing Animals.......Mr. Lawrence
Oct. 28. Adaptations to Environment—Life in the Ocean, Professor Schmucker
Nov. 4. Great Groups of Plants—Violet Family............Professor Kaiser
Nov. 11. Water Birds and Land Birds of Water Habitat—Birds of the Open Sea. Albatross—Petrels—Man o'War Birds........Miss Borden
Nov. 18. Skins of Animals—Fur Bearing Land Animals........Mr. Lawrence
Nov. 25. Adaptations to Environment—Life in Fresh Water
Professor Schmucker
Dec. 2. Great Groups of Plants—Grape Family............Professor Kaiser
Dec. 9. Water Birds and Land Birds of Water Habitat—Birds Found Near Shore and in Bays. Loons—Gulls—Terns—Flamingoes
Miss Borden
Dec. 16. Adaptation to Environment—Life Between Water and Land
Professor Schmucker
Dec. 23. Skins of Animals—Domestic Animals That Help to Clothe Us
Mr. Lawrence
Jan. 6. Great Groups of Plants—Heath Family............Professor Kaiser
Jan. 13. Water Birds and Land Birds of Water Habitat—Birds of the Beaches and Shores. Curlews—Sandpipers—Oyster Catchers—Spoonbills
Miss Borden

Jan. 20. Skins of Animals—Fur Trapping in Pioneer Days.....Mr. Lawrence

Jan. 27. Adaptation to Environment—Life on the Ground
Professor Schmucker

Feb. 3. Great Groups of Plants—Ebony and Primrose Families
Professor Kaiser

Feb. 10. Water Birds and Land Birds of Water Habitat—Birds of the Bayous and Marshes. Grebes—Ibises—Egrets—Rails.......Miss Borden

Feb. 17. Skins of Animals—Fur Raising as an Industry. Fox Farms, Skunk Farms, Muskrat Farms, etc......................Mr. Lawrence

Feb. 24. Adaptation to Environment—Life Beneath the Ground
Professor Schmucker

Mar. 3. Great Groups of Plants—Olive and Gentian Families, Professor Kaiser

Mar. 10. Water Birds and Land Birds of Water Habitat—Birds of Fresh-Water Lakes and Rivers. Ducks—Geese—Swans—Herons...Miss Borden

Mar. 17. Skins of Animals—The Preparation of Skins for the Market
Mr. Lawrence

Mar. 24. Adaptation to Environment—Life in the Trees...Professor Schmucker

Mar. 31. Great Groups of Plants—Madder Family..........Professor Kaiser

Apr. 7. Great Groups of Plants—Gourd Family...........Professor Kaiser

Apr. 14. Water Birds and Land Birds of Water Habitat—Birds Found Near Wooded Streams and Ponds. Kingfishers—Nighthawks—Woodcocks.......................................Miss Borden

Apr. 21. Skins of Animals—Modifications of the Skin—Nails, Hoofs, Claws, Hair, etc...................................Mr. Lawrence

Apr. 28. Adaptation to Environment—Life in the Air....Professor Schmucker

MUSEUM TALKS (By Topics)

Monday Evenings at 7 o'clock

Skins of Animals

Mr. Lawrence

Sept. 30. Skins of Animals—Their Functions and Uses
Oct. 21. Aquatic Fur Bearing Animals
Nov. 18. Fur Bearing Land Animals
Dec. 23. Domestic Animals That Help to Clothe Us
Jan. 20. Fur Trapping in Pioneer Days
Feb. 17. Fur Raising as an Industry—Fox Farms, Skunk Farms, Muskrat Farms, etc.
Mar. 17. The preparation of Skins for the Market
Apr. 21. Modifications of the Skin—Nails, Hoofs, Claws, Hair, etc.

Great Groups of Plants

Professor Kaiser

Oct. 7. Nettle Family
Nov. 4. Violet Family
Dec. 2. Grape Family
Jan. 6. Heath Family
Feb. 3. Ebony and Primrose Families
Mar. 3. Olive and Gentian Families
Mar. 31. Madder Family
Apr. 7. Gourd Family

Water Birds and Land Birds of Water Habitat

Miss Borden

Oct. 14. Bird Study: Structure—Color—Feathers—Classification
Nov. 11. Birds of the Open Sea. Albatross—Petrels—Man o'War Birds
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Apr. 14. Birds Found Near Wooded Streams and Ponds. Kingfishers—Nighthawks—Woodcocks

Adaptation to Environment

Professor Schmucker

Oct. 28. Life in the Ocean
Nov. 25. Life in Fresh Water
Dec. 16. Life Between Water and Land
Jan. 27. Life on the Ground
Feb. 24. Life Beneath the Ground
Mar. 24. Life in the Trees
Apr. 28. Life in the Air

GENERAL SCHEDULE OF REGULAR LECTURES

Subjects of courses in each of the four successive years constituting a full term.

ENGINEERING

1. Materials of Engineering Construction.
2. Civil Engineering Structures.
3. Roads, Railroads and Tunnels.
4. Water Supply, Sewers, Canals, Rivers and Harbors.

PHYSICS

1. Properties of Matter. Mechanics.
2. Heat and Sound.
3. Light.
4. Electricity and Magnetism.

INORGANIC CHEMISTRY

1. General Principles, Notation, Nomenclature.
2. Descriptive Chemistry.
3. Descriptive Chemistry.
4. Descriptive Chemistry.

ORGANIC CHEMISTRY

1. General Principles, Aliphatic Hydrocarbons.
2. Carbohydrates, Fats, Oils and Waxes.
3. Cyclic Hydrocarbons.
4. Compounds Containing Nitrogen.

ZOOLOGY

1. Invertebrate Animals.
2. Vertebrate Animals.
3. Human Biology.
4. Principles of Animal Life.

BOTANY

1. Morphology.
2. Taxonomy.
3. Taxonomy (continued).
4. Physiology and Ecology.

GEOLOGY AND PALEONTOLOGY

1. Physical Geography.
2. Physical Geology.
3. Paleontology.
4. Historical Geology.

PUBLICATIONS OF THE INSTITUTE

TRANSACTIONS

Vol. 1.—Explorations on the West Coast of Florida and in the Okeechobee Wilderness *Angelo Heilprin.* $2.50

Vol. 2.—Report on Fresh-water Sponges Collected in Florida. *Edward Potts*
Notice of Some Fossil Human Bones. *Joseph Leidy.*
Description of Mammalian Remains from Rock Crevice in Florida. *Joseph Leidy.*
Description of Vertebrate Remains from Peace Creek, Florida. *Joseph Leidy.*
Notice of Some Mammalian Remains from Salt Mine of Petite Anse, Louisiana. *Joseph Leidy.*
On Platygonus, an Extinct Genus Allied to the Peccaries. *Joseph Leidy.*
Remarks on the Nature of Organic Species. *Joseph Leidy.* $1.00

Vol. 3.—Parts 1, 2, 3, 4, 5, 6.—Contributions to the Tertiary Fauna of Florida *William H Dall.* $15.75

Vol. 4.—Fossil Vertebrates from the Alachua Clays, Florida. *Joseph Leidy.* $1.25

Vol. 5 —Study of Hawaiian Skulls. *Harrison Allen.*
Notes on the Palæontological Publications of Prof. William Wagner *William H. Dall.* $1.00

Vol 6.—Selenodont Artiodactyls of the Uinta Eocene. *William B. Scott.* $1.00

Vol. 7.—Contributions to the Mineralogy of the Newark Group in Pennsylvania. *Edgar T. Wherry.*
A Comparative Study of the Radio-Active Minerals in the Collection of the Wagner Free Institute of Science. *Carl Boyer and Edgar T Wherry.* $0.50
Vegetation of South Florida. *John W. Harshberger.* $2 50
Studies in Carbohydrates *Charles H. LaWall and Sara S. Graves.* $0 50

Vol. 8.—Special Lectures by the Teaching Staff of the Institute. $2 00

Vol. 9.—Part 1.—The Vegetation of the Hackensack Marsh A Typical American Fen. *John W. Harshberger and Vincent G. Burns.* $1.00
Part 2 —On the Life History of an Economic Cuttlefish of Japan; Ommastrophes sloani pacificus. *Madoka Sasaki.* $1 00

Vol. 10.—Contributions by the Faculty of the Institute. Post-fixation Development. *H. Leffmann.* Reconstruction of Columbia Bridge. *S. T. Wagner.* Origin and Relationship of North American Song Birds. *S. Trotter.* The Three-Electrode Bulb in Radio Signals. *L. B. Seely* Detection of Methanol in Presence of Ethanol. *C. H. LaWall* Chemical Attraction. *D. W. Horn.* $2.00

Vol. 11.—Biochemistry of American Pitcher Plants. *Joseph S. Hepburn, Elisabeth Q. St. John and Frank M. Jones.* $2 50

PUBLICATIONS

Vol. 1.—A Revision of the Ostracod Genus *Kirkbya* and Subgenus *Amphissites.* *Robert Roth.* $1.00

BULLETIN

Bulletin of the Institute. Bimonthly $1.00 per year
Single numbers, 20 cents

Republication of Conrad's Fossils of the Medial Tertiary of the United States. Introduction by *William H. Dall.* (Out of Print.)

BULLETIN

of the

WAGNER FREE INSTITUTE OF SCIENCE OF PHILADELPHIA

PUBLISHED BY THE INSTITUTE

Edited by the Publication Committee

HENRY LEFFMANN SAMUEL TOBIAS WAGNER

Vol. 4	Bi-Monthly	$1.00 per year
No. 5	October, 1929	Single numbers, 20 cents

ANNOUNCEMENTS

THE regular Lecture Courses were resumed according to schedule, beginning September 6th. The attendance and enrollment have been very satisfactory. The fall lecture courses are on Engineering, Inorganic and Organic Chemistry and Botany. The time for the beginning of the lectures on Inorganic Chemistry has been fixed at 7.45, but the other lectures begin at 8. The Museum Talks are scheduled for Mondays, 7 to 8 P.M., continuing through the scholastic year, except interruptions for legal holidays and the Christmas vacation period.

Professor Horn, who was granted leave of absence for the session of 1928–9 on account of illness, has resumed his lecture work.

In addition to the scheduled courses for instruction in science with enrollment of students, special lectures on topics of general interest will be appointed from time to time during the session. Due notice of such lectures will be given, Saturday evenings being mostly chosen for them.

The annual Announcement giving information as to all the educational activities of the Institute will be sent on request. Further inquiries should be made at the office, which is open from 9 A.M. to 5 P.M. and 7 P.M. to 9 P.M. on all business days.

Entered as second-class matter, September 10, 1926, at the Post Office, Philadelphia, Pa., under Act of August 24, 1912.

INSTITUTE NEWS AND NOTES

During the summer extensive repairs have been made to the lecture-hall. It has been entirely repainted, the platforms and aisles covered with a heavy linoleum, and the lighting system thoroughly overhauled and brought up to date both as to illumination and safety. Convenient methods of control of the lighting have been included in the work.

Professor Samuel Tobias Wagner, President of the Institute, has been appointed by Governor Fisher a member of the State Registration Board for Professional Engineers, succeeding Dr. Henry S. Drinker, resigned.

During his vacation the Director visited the Park Musuem in Providence and the Museum of the Boston Society of Natural History to study the methods used in these institutions. The Museum assistant spent a short time at the Woods Hole Biological Station.

SPECIAL MUSEUM WORK

In addition to the routine work of cleaning specimens and cases, considerable progress was made in methods of group-mounting and in the paraffine infiltration-method of preparing reptile specimens. In the latter procedure, Gilson's fluid was used as a fixative in place of Bouin's acetic-formal-picric acid suggested by Noble and Yakens in *Amer. Mus. Novitiates*, Nov., 1926.

Specimens were dehydrated by the usual method with increasing strengths of alcohol. Terpineol was found satisfactory as a clearer. Xylene removed the terpineol and the specimens were then placed in a xylene-paraffine mixture for twenty-four hours and from this to a paraffine bath of constant temperature of 61° C. in a home-made oven heated by a 200-watt lamp. The finishing touches were given by injecting the specimen with hot paraffine from a syringe. The results are quite satisfactory.

FURTHER NOTES ON TESTS FOR ACETONE AND ALDEHYDE

HENRY LEFFMANN and CHARLES C. PINES

The experiments on the detection of methanol in the presence of ethanol recently published in the *American Journal of Pharmacy* (1929, **101**, 584) led to trials of a number of tests for acetone, formaldehyde and acetaldehyde, especially with a view of obtaining trustworthy methods for the detection of each of these compounds in the presence of the others. Notes on some newly proposed tests, and a brief review of tests long in use, were presented in a paper in the May issue of the *Amer. Journal of Pharmacy*, and a short paper on the reactions of dimethyldihydroresorcinol, according to the procedure of Stepp, appeared in a previous issue of this BULLETIN (1929, **4**, 15). Most of the tests for these substances depend on color-formation, about which there may be uncertainty, but several of the newer tests give definite crystalline precipitates. The principal phases of the problem are: the definite detection of acetone in the presence of aldehydes and of acetaldehyde in the presence of formaldehyde. Aldehydes may be detected in the presence of acetone by several tests, such as the reduction of alkaline silver nitrate, Stepp's reagent (noted above) and the formation of a resinous compound in presence of strong alkali. Stepp's reagent gives crystalline precipitates with many aldehydes but not with acetone.

The literature of the subject is extensive, but, as noted in a previous paper, the tests are generally not collated so as to determine how far they are characteristic. Bülow's test for acetone (2–4 dinitrophenylhydrazin) gives a well-marked crystalline precipitate with small amounts of acetone, but also with formaldehyde and acetaldehyde. Some tests have been proposed in qualitative organic analysis, based, unwittingly, on impure reagents or on reactions with unsuspected impurities in the substance tested. Kekulé's test for benzene was found to be due to thiophene, and the test for isopropanol given in U.S.P. X is now known to be due to tertiary butanol. Merck's Report (1929, **37**, 115) lists a test for acetone credited to Fritsch (without reference to the literature), using a solution of rhamnose in hydrochloric acid. We tried this with

acetone, formaldehyde and acetaldehyde, using a sample of Pfanstiehl's c.p. rhamnose, but obtained no result except a slight yellow tint with acetaldehyde. Perhaps an impure rhamnose was used in the original experiment.

It has already been pointed out in the article in the August issue of the *American Journal of Pharmacy* that the solution suggested by Matthes (*Pharm. Zeits.*, 1926, No. 96), potassium guaiacolsulphonate in strong sulphuric acid, is entirely satisfactory for detecting formaldehyde in the presence of acetaldehyde, a condition that is of much importance in the detection of methanol in the presence of ethanol, especially as it eliminates the error due to glycerol. Matthes prescribed a dilute solution of the sulphonate (40 mg. to 10 cc. of the acid), but we have found that much stronger solutions may be used with advantage, and recently have been using 1 gram to 10 cc. of acid.

Among the familiar tests for acetone is with sodium nitroprussid and alkali. This gives a similar result with acetaldehyde, but the simulation is of little moment in the use of the test for clinical purposes. In a previous paper attention was called to a test in which ethylenediammonium hydroxide is substituted for the fixed alkali. No reference to the original publication could be found, so that it is not possible to say what controls were made. The reagent is not listed by the Eastman Company, but the corresponding chloride is. An attempt was made to prepare the hydroxide by the action of moist silver oxide, but the method failed on account of the solution of the silver chloride in the alkaline liquid. We were led to substitute ethylamine, which is now available as a 33% water solution (presumably ethylammonium hydroxide). A small amount of a diluted solution of acetone was mixed with nitroprussid solution and a few drops of the ethylammonium solution added. A red ring was promptly formed at the contact-zone. The two aldehydes similarly treated did not give a similar reaction. We have found some advantage in using a nitroprussid solution in concentrated glycerol, which keeps for some time if protected from light. Our experiments have, indeed, indicated a certain degree of photosensitiveness in the solution of nitroprussid, a point that will be investigated later.

The detection of acetone and formaldehyde in association seems to be solved by the use of ethylamine solution for the former and guaiacolsulphonate for the latter, but when acetaldehyde is also present, the problem is much more complicated and requires further study.

Merck's Report (1926, **35**, 98) gives a test for acetone (ascribed to Drewsen, but without reference to the literature) depending on the reaction of ortho-nitro-benzaldehyde in moderately alkaline solution. The procedure, originally published by Baeyer and Drewsen (*Ber.*, 1882, **15**, 2856), was introduced as a method for the manufacture of indigo, but was not commercially successful. It is of no practical value as a test, since the aldehyde has to be dissolved in the acetone, and thus can only be applied when considerable amounts are present. In addition B. & D. state that acetaldehyde gives the reaction.

We were unable to obtain a pure sample of o-nitrobenzaldehyde, the Eastman Co. listing only a mixture of o & m, apparently containing but little of the former. This was merely a "technical" sample, therefore, without guarantee as to freedom from other substances. Attempts to prepare the ortho-form by oxidation of o-nitrotoluene with manganese dioxide, as described in an English patent, also failed. Experiments with the mixture of the o & m forms of the aldehyde gave occasionally minute amounts of a bluish-black precipitate, but as noted above the procedure seems to depend on the presence of considerable amounts of acetone and was not originally listed as a test, but as a commercial process.

In the field of patent literature and the journal abstracts of such, much obscurity exists. Specifications for process patents are rarely frank and explicit, and it is not unlikely that some important part of the procedure with which we were dealing is not precisely expressed.—*Research Laboratory, Wagner Free Institute of Science.*

PRELIMINARY NOTE ON SOME STUDIES OF THE PHOTOSENSITIVENESS OF NITROPRUSSIDS

Henry Leffmann and Charles C. Pines

Compounds of the general formula $MFeC_5N_5$ (NO) were first prepared and described by Dr. Lyon Playfair (pronounced "Pluffer") in a communication to the Royal Society in 1849 (*Phil. Trans.*, 1849, 477), republished in German in Liebig's *Annalen* (1850, **74**, 317). It was quite lengthy, containing much discussion on analytic data and speculations as to formulas, about which there was then some uncertainty. In 1869 Staedeler reviewed the subject at considerable length in the *Annalen* (**151**, 1), assuming the iron to be in tetrad

valency. Playfair gave the name "nitroprussid" to the compounds, many of which he prepared. The name is unsatisfactory, as the iron is not mentioned and the group NO should be indicated by "nitroso." The sodium compound is the only one now familiar in the laboratory, and its systematic name, "sodium ferri-nitroso-cyanid," is too cumbrous. Playfair makes some incidental allusions to the color-changes of the compounds by the action of light but lays no emphasis on them.

In 1863, Z. Roussin published a paper in *Jour. de Pharmacie* ([3], **44**, 408) describing the marked sensitiveness of sodium nitroprussid to light and suggesting that it might be used as a means of measuring the intensity thereof. He also suggested a mixture of the salt and ferric chlorid for impregnating paper to obtain blue prints.

Our attention has been attracted to the literature of this subject by noting that a solution of the nitroprussid in absolute glycerol has far better keeping qualities than that in water. We have verified Roussin's statement that even the water solution may be preserved for a considerable time in the dark. Inasmuch as the data so far available seem to be limited to a study of the action of ordinary daylight, with or without direct sunshine, on the sodium salt dissolved in water, it is our intention to extend investigation to other nitroprussids and to determine whether the compounds, especially that of sodium, have special susceptibilities to different wave-lengths. Roussin found that the sodium nitroprussid solution is not appreciably affected by heating to 100°, if not exposed to light. Many of the nitroprussids are insoluble in water and can, therefore, be prepared by double decomposition. It will be interesting to determine how far these compounds are differently affected by ultra-violet and infra-red radiations; also what effect the presence of organic substances, such as gelatin and agar, may have. These are points that we hope to investigate at an early date. Strong solutions of sodium nitroprussid in water were mixed respectively with uranium acetate, silver nitrate, mercuric nitrate, ferrous sulphate and ferric chlorid. Precipitates were formed with all but ferric chlorid. These precipitates were notably changed by ten minutes' exposure to full sunlight, except that of uranium, which was scanty and light brown and darkened but slightly. The ferric chloride gave no precipitate but darkened very much on exposure.

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WAGNER FREE INSTITUTE OF SCIENCE

Montgomery Ave. and Seventeenth St., Philadelphia, Pa., U. S. A.

BULLETIN

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WAGNER FREE INSTITUTE OF SCIENCE OF PHILADELPHIA

PUBLISHED BY THE INSTITUTE

Edited by the Publication Committee

HENRY LEFFMANN   SAMUEL TOBIAS WAGNER

Vol. 4	Bi-Monthly	$1.00 per year
No. 6	December, 1929	Single numbers, 20 cents

ANNOUNCEMENTS

THE regular lectures and museum talks have continued according to Schedule with satisfactory attendance and interest on the part of the registered students. At the meeting of the Trustees on October 16, a change was made in the arrangements of the lectures by which each course now includes fourteen lectures. Careful supervision is kept over the attendance of the registered students by which a high standard of instruction is maintained without impairing the general public interest. The change in the number of lectures will permit beginning the courses somewhat later in the fall, thus avoiding the hot weather not infrequently occuring at that season, and also of closing the course somewhat earlier than heretofore in anticipation of the midwinter holidays. No change has yet been made in the museum talks.

The improvements in the auditorium, especially in the lighting, have proved very satisfactory.

In addition to the scheduled courses for instruction in science with enrollment of students, special lectures on topics of general interest will be appointed from time to time during the session. Due notice of such lectures will be given, Saturday evenings being mostly chosen for them.

The annual Announcement giving information as to all the educational activities of the Institute will be sent on request. Further inquiries should be made at the office, which is open from 9 A.M. to 5 P.M. and 7 P.M. to 9 P.M., on all business days.

Entered as second-class matter, September 10, 1926, at the Post Office, Philadelphia, Pa., under Act of August 24, 1912.

INSTITUTE NEWS AND NOTES

Among the exhibits in the Museum is a synoptical collection, which, in addition to typical specimens, illustrating the principal groups of the animal kingdom, comprises many drawings and labels with descriptive matter. As these have become out of date due to changes in classification, an entire revision of the synoptic collection is being made. New drawings, tinted and colored, to show internal structure, have been made and the descriptions revised and rewritten.

By resolution of the Trustees at the meeting on October 16 the income of the fund, heretofore known provisionally as the "Chemistry Endowment," has been divided so as to devote a definite portion to the promotion of research in chemistry, constituting the "Henry Leffmann Chemistry Research Fund," and the remainder of income to the establishment of a special lecture course, to be designated the "Fannie Frank Leffmann Memorial Lectureship."

The first lecture under the latter foundation was delivered on Saturday, November 16, 1929, by Dr. Howard McClenahan, Secretary of the Franklin Institute, the subject being, "A Great Scientific Museum for Philadelphia."

The City History Society of Philadelphia schedules visits to places of historic interest in and about Philadelphia during the spring and fall, and to museums and educational institutions during the "inverted year." Under this arrangement a visit was paid on November 2nd to the Institute. After inspection of the Museum, the guests adjourned to the auditorium, where some experiments in electricity and ultra-violet light were shown, followed by an exhibition of amateur motion pictures.

Mr. Lester W. Strock, author of the paper on "A Study of the Pensauken Formation" (*Bull. W. F. I.*, 1929, 4, 3), made a collecting trip to Nova Scotia during the summer and presented to the Institute thirty-six specimens of zeolites therefrom.

The 1930 Westbrook Free Lectureship Course will be delivered by Professor Edwin G. Conklin, Princeton University, who has chosen for his topic "The Direction of Human Evolution." The lectures are scheduled for early in March, 1930.

[*Bulletin, Wagner Free Institute of Science of Philadelphia,* 1929, 4]

NOTES ON THE TESTS FOR ISOPROPANOL

HENRY LEFFMANN AND CHARLES C. PINES

An alcohol of the formula C_3H_8O was first isolated and examined by G. Chancel (*C. r.* 1853, **37**, 410). He obtained it from the marc of grapes and recognized that its formula placed it between ethyl and butyl alcohols. At that time the stereoisomerism of organic substances had not been developed and Chancel did not inquire into the exact structure of the molecule.

In 1862, C. Friedel obtained the alcohol by the prolonged action ("einige Tage") of sodium amalgam on acetone. *Annalen*, 1862, **124**, 324. Somewhat later, Kolbe (*Zeits. Chem. u. Pharm.*, 1862, 617; also *Chem. Centr.* 1863, 268) suggested that the name should be "monomethylated ethyl alcohol." Kolbe's views concerning the structural formulas of organic substances were rather peculiar, but he was evidently on the way to a correct interpretation of the data so far obtained.

At present two forms of propanol are definitely recognized. By treatment of some hydrocarbons existing in natural gas and allied products, an impure isopropanol is obtained and is now in large supply. This has given rise to sanitary and pharmaceutic problems similar to those developed about a quarter of a century ago, when a highly purified methanol began to be abundantly produced. The temptation to substitute a liquid, untaxed and freely sold, for one heavily taxed and sold under severe restrictions, is too much for human frailty. Legislation and supervision have practically removed the methanol menace, but the isopropanol problem is, as our French brethren would say, "une question actuelle."

The problem already required solution when the current U. S. Pharmacopeia was in preparation, and a provisional test was inserted in the alcohol rubric. It was soon discovered, however, that the reaction was really due to tertiary butanol and that some commercial samples of isopropanol would not show it. Research has been actively directed to securing a

dependable test. The obvious method is to take advantage of the fact that the secondary alcohols yield acetones on restrained oxidation, while the primary forms yield aldehydes. Development along this line is somewhat complicated by the fact that the detection of acetone in the presence of much aldehyde is not easy, as has been shown recently in some reports of our own experiments.

A detailed method for applying acetone-production to the detection of all commercial forms of isopropanol is described by J. Rae in *Pharm. J.*, 1926, **116**, 630. The procedure is merely to oxidize 10 cc. of the sample by a mixture of 20 cc. of a 1% solution of potassium dichromate with 1 cc. of strong sulphuric acid, distilling 3 cc. and testing this with sodium nitroprussid solution containing strong ammonia and a small amount of ammonium chloride. Inasmuch as acid dichromate keeps indefinitely, we made up a solution of closely approximate strength to that prescribed by Rae and used it in a series of tests. An alcohol of approximately 50% made up by diluting the laboratory alcohol with an equal volume of water was used in all the tests. Rae's method involves superposing the distillate on the nitroprussid solution, a difficult matter when the liquids are of nearly the same sp. gr. To obviate this, we have used a 1% solution of nitroprussid in concentrated glycerol. As the addition of the ammonia-ammonium chloride solution would dilute this glycerol solution very much we add the former to the distillate. A sharp separation between the liquids is thus obtained without difficulty, and a trace of acetone will show a ring at the contact zone. We have called attention in a previous contribution to the fact that a glycerol solution of nitroprussid keeps somewhat better than a solution in water, and that the latter can be kept in good condition for a long while if not exposed to light.

The following experiments carried out by Rae's method with the modifications noted, show that it is satisfactory for the detection of such amounts of isopropanol as are likely to be found in commercial ethyl alcohol. Dr. Chas. H. LaWall kindly furnished us with a sample that does not contain tertiary butanol and, therefore, does not react with the mercuric sulphate test. This sample and ordinary isopropanol

were used in the experiments. In the following list of experiments and results, A represents the approximately 50% alcohol noted above. The amount of other alcohols added was about 10%.

Sample			Result of test
A			negative
A	with	normal propanol	"
A	"	isopropanol	positive
A	"	normal butanol	negative
A	"	isobutanol	"
A	"	secondary butanol	faint ring
A	"	tertiary butanol	negative

Herstein's test. The *Practical Druggist* for Nov., 1922 (p. 38), contains a communication from Dr. S. Levinson, describing several tests for isopropanol, among which is one stated to have been devised by C. Herstein. It consists in adding to the sample three drops of strong sulphuric acid, 1 cc. of a 30% solution of sodium hydroxide, several cc. of a solution of sodium nitroprussid and from 1 to 2 cc. of glacial acetic acid. Presence of isopropanol is indicated by the development of a dark red solution. We tried this test and found to our surprise that it was positive with the sample of isopropanol that does *not* react with mercuric sulphate and negative to the one that does. Negative results were also obtained with methanol, ethanol, normal propanol and all four forms of butanol. The experiments were carried out as in the cases recorded above, that is portions of the approximately 50% alcohol were mixed with 10% of the other alcohols and the mixtures tested carefully by the method.

Substitution of 1 cc. of 28% ammonium hydroxide for the 1 cc. of sodium hydroxide made no appreciable change in character or delicacy of the test.

We have also experimented with the test developed in the laboratory of the Federal Prohibition Commissioner by Messrs. L. E. Dale and P. W. Simonds. It is as follows:

To 1 cc. of the sample add 1 cc. of a saturated solution of disodium acid phosphate and 3 cc. of saturated solution of

potassium permanganate. Warm the mixture, but not to the boiling point, and allow it to stand until the permanganate is completely decomposed. Add 3 cc. of a 10% solution of sodium hydroxide and 1 cc. of a 1% solution of furfural and filter. Add to 1 cc. of the filtrate several cc. of strong hydrochloric acid. This part of the reaction may be aided by slight warming. Isopropanol is shown by a marked color ranging from pink to cherry red.

This test gave positive results with both samples of isopropanol.

Summary

Rae's method and that devised by Dale and Simonds seem to suffice to detect such quantities of isopropanol as are likely to be in ordinary alcohol or plain spirits. Methods for its detection in complex mixtures, such as cologne, tinctures and other official preparations have been proposed. We hope to review some of these later.

Herstein's test seems to be in the same class as that with mercuric sulphate, that is, due to some impurity. If the two forms tested represent the only forms of isopropanol occurring in commerce, the detection of the compound will be very easy in many cases.

In the distillation work in connection with these experiments we have used with satisfaction and convenience, the microdistillation apparatus described by one of us in *Amer. Jour. Pharm.*, 1924, **96**, 506.

Henry Leffmann Chemistry Research Fund.
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WM. OTIS SAWTELLE HENRY LEFFMANN
SAMUEL TOBIAS WAGNER, *Ex-officio*

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ANNOUNCEMENTS

THE regular instruction courses of the Institute were resumed according to schedule and have continued with satisfactory attendance. The improvements in the lecture hall have been of much benefit, especially the arrangement of the illumination. During the year just passed, many useful additions have been made to the library and museum.

The Westbrook Free Lecture course will be delivered in three lectures, Saturdays, March 1, 8 and 15 at 8.00 P.M. in the hall of the Institute, by Dr. Edwin G. Conklin of Princeton University, on "Present Problems of Evolution." An abstract of the syllabus is presented on the next page. The full syllabus will be distributed at the lectures.

The annual Announcement giving information as to all the educational activities of the Institute will be sent on request. Further inquiries should be made at the office, which is open from 9 A.M. to 5 P.M. and 7 P.M. to 9 P.M., on all business days.

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THE RICHARD B. WESTBROOK FREE LECTURESHIP, 1930
WAGNER FREE INSTITUTE OF SCIENCE
Montgomery Avenue and Seventeenth Street, Philadelphia, Pennsylvania

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ABSTRACT OF SYLLABUS
of
THREE LECTURES ON "PRESENT PROBLEMS OF EVOLUTION"

By Edwin Grant Conklin, A.M., Ph.D., Sc.D., LL.D.
Henry Fairfield Osborn Professor of Biology, Princeton University

Saturdays, March 1, 8, 15, at 8 p. m.

Admission Free

Lecture 1.—Present Problems of Evolution concern the Methods and Causes of Transformations. The origin of individuals is the key to the origin of species. Methods and Causes of Development. Germ cells, their origin and union. The Constitution of the Egg is Heredity; the stimuli represent Environment.

Lecture 2.—Changes leading to evolution must be inherited; changes in development are due to changes in environment. The former are termed "Mutations," the latter, "Fluctuations." These terms were confused before the work of De Vries.

The mechanism of heredity according to Darwin, Weismann, Mendel, De Vries, Morgan. The chromosomes of the nucleus are the seat of the inheritance units (genes). Evolution consists in change in germ cells rather than in adult cells. Changes in germ cells may be: (1) New combinations of chromosomes (Mendelism); (2) New combinations of genes in chromosomes (crossovers); (3) New constitutions of genes (gene mutations). The first is produced by hybridization; the causes of (2) and (3) are obscure.

Lecture 3.—Fitness (adaptation) is characteristic of living organisms. It seems to be due to natural causes. Adaptations are of two kinds: Individual (contingent), racial (inherited). The former occurs in developed organism by changes in environment: the latter in the constitution of the germ cells and hence inherited. Lamarckism holds that the somatic adaptations are impressed upon the germ cells and the acquired characters inherited. This has not been proved. Darwinism holds that mutations occur in all possible ways but that only the fit survive.

There is good reason to think that many adaptations, whether individual (somatic) or racial (germinal), are the result of elimination of unfit mutations of the germ or of unfit responses of the body, and, therefore, that such fitness is the result of the survival of the fit and the elimination of the unfit.

[*Bulletin, Wagner Free Institute of Science, Philadelphia, February, 1930.*]

THE QUALITY OF COMMERCIAL ETHER

HENRY LEFFMANN AND CHARLES C. PINES

Several grades of ethyl oxide are common in the market. Two especially need supervision—the anhydrous for analytic work and that for anesthesia. The quality of the latter and methods of testing are provided in the pharmacopeias of the several nations. Some discussion has lately arisen concerning the possibility of anesthetic ether producing irritation and even inflammation of the respiratory tract. An editorial in *Industrial and Engineering Chemistry* (1929, 21, 995) mentions a specific case, in which aldehyde and peroxide were found in a hospital sample that had apparently caused serious irritation. Unfortunately, no information is given as to name, place, source of the sample or the tests used. Irritation and even serious gastric disturbances may be caused by inhalation of ether. Much depends on the manner of administration. One of us (L.) has been twice under the influence of the drug, administration being on both occasions by well-known surgeons. One of these had little experience in inhalation and his method produced much disturbance. The other had paid much attention to such administration and had devised several forms of inhalers. He gave the ether skilfully, anesthesia being produced rapidly and smoothly. L. has also seen many operations in which ether was used and has noted much difference in susceptibility. In the purest form it is somewhat irritating, and in view of great prevalence of respiratory troubles at the present time owing to the air impurity in our cities, it is not surprising that inflammation should occasionally develop.

Notwithstanding these facts, it is incumbent upon manufacturers to keep their product as pure as possible, and makers of pharmacopeias must provide comprehensive and trustworthy control tests. In the practical application of these rules, supervision must come from federal and state authorities. Retail druggists cannot be expected to carry out the complex procedures necessary for such control. In hospitals, of course, the laboratory can do much towards preventing the use of impure materials.

A comprehensive study of commercial ether and of the tests for impurities carried out by Baskerville and Hamor was published in *Industrial and Engineering Chemistry* (1911, 3, 378). They reviewed a large number of tests, determining limits of delicacy, possibilities of errors of inference, and gave a summary suggesting procedures to which a given sample should be submitted in order to assure its suitability for anesthetic use.

The discussion that has recently arisen relates, as noted above, to the presence of aldehyde, presumably acetaldehyde, and peroxide, possibly hydrogen peroxide. Tests for these classes of impurity are fully reviewed in the paper above noted, but it must be borne in mind that it was published eighteen years ago. Since then, considerable progress has been made in the field. This seems to be especially true of the discussion of the use of the fuchsin-sulphurous test for aldehyde. B. and H. do not give the method they used in preparing the test solution. We have used with much satisfaction the formula proposed by Fincke (*Zeits. Unters. Nahr. Genuss.*, 1914, 27, 248, also *Amer. Jour. Pharm.*, 1927, 99, 289). The solution differs from the usual formulas by containing much more hydrochloric acid. We have been using a solution that was made several months ago, still entirely satisfactory, having been kept in the dark. We have investigated the action of this solution on samples of commercial ether with the following results. It must be borne in mind that the test is very delicate and also that it seems that tin containers in which ether is usually sold may have a direct action in developing acetaldehyde or some substance giving a similar reaction.

The first four samples are anesthesia ether. The color was observed after 15 minutes.

Source and Type of Sample	*Container*	*Reaction*
1. Squibb (very old sample)	Ordinary tin	Very marked red
2. Squibb (recent sample)	Patented tin	Very faint tint
3. Merck	Ordinary tin	Very faint tint
4. Mallinckrodt	Ordinary tin	Distinct red
5. Baker's anhydrous	Ordinary tin	Distinct red
6. Merck's anhydrous	Amber bottle	Extremely faint tint
7. Baker's washed	Ordinary tin	Distinct red

It is interesting to note the very faint reaction given by that in the glass bottle, the only sample in the lot so preserved.

Finding Merck's anhydrous ether so nearly free from anything reacting with the Fincke solution, we used it for testing the delicacy of the reaction. One drop of a solution containing somewhat less than 1% of acetaldehyde was added to 25 cc. of the ether. After mixing, a small amount was tested. After 15 minutes a very faint tint was noted. A similar experiment was then made with two drops of the acetaldehyde solution to 25 cc. A faint but distinctly noticeable tint was produced after 15 minutes.

The existence of peroxides in ether has also been noted. Baskerville and Hamor gave full attention to this phase and discussed the tests for the substances, which are often assumed to be, principally, hydrogen peroxide, but may, of course, be other forms. We studied the reaction with acid dichromate, using a solution containing 1 grm. of potassium dichromate and 5 cc. of strong sulphuric acid in 100 cc. of water. About

1 cc. of each of the above samples was placed in test-tubes and 1 cc. of the dichromate solution dropped in. By this means the reagent passes *through* the sample to be tested, and if a peroxide is present the reaction occurs at once. The liquids should not be shaken, nor should the ether be poured on the reagent. (The same method was applied by us in testing for aldehyde. Equal portions of the reagents were poured into approximately equal portions of the several samples.) In the test of the seven samples for peroxide, Baker's anhydrous ether gave faint bluish tint but nothing was noted in the others. 50 cc. of the Baker sample was then mixed with one drop of hydrogen peroxide (U.S.P.X) and a small portion tested. A distinct blue tint appeared promptly. The addition of two drops to the unused portion of the mixture showed a deeper blue.

So far as the anesthetic ether on the market is concerned, it appears to contain but little acetaldehyde, if fresh, but it seems that plain tin containers tend to cause changes by which this substance is produced. The quality of Merck's anhydrous ether marketed in a deep amber glass bottle is worthy of note.

Tests for aldehyde with Nessler's Reagent gave for the seven samples results strictly in accordance with those of Schiff's Reagent.

We have also applied the vanadic oxide test as described by Baskerville and Hamor in the paper above noted and the U.S.P.X test to all the samples. The last named was continued for only a limited time. Vanadic oxide showed a characteristic color with sample No. 5; with the iodide test, sample No. 1 showed a faint color, and No. 5 a distinct effect. Pieces of starch paper were dropped into these samples. That in No. 1 acquired after some time a faint blue tinge, especially on the edges, but the paper in No. 5 became soon deep blue throughout. The iodide test seems to be very severe. For practical purposes the chromic acid test will probably suffice. The delicacy of the chromic acid test is shown by the fact, one drop of U.S.P.X hydrogen peroxide in 25 cc. of Merck's anhydrous ether (chosen on account of having been marketed in glass) gave promptly and distinct a blue when a volume of a few cc. was tested by dropping acid chromate solution through it. Since 100 cc. of the hydrogen peroxide contains as nearly as may be 3 grm. of real peroxide, 1 cc. will contain 30 milligrams. One drop is about one-fifteenth of a cc., so that the amount of peroxide added to the 25 cc. of ether may be safely assumed as 2 mg.

Sample No. 2 was transferred to a bottle and the container opened. It was lightly copper-plated on the side and base, but the top was plain tin. The whole plated surface was tarnished and the soldering lines were bare. Containers of such construction standing quietly in the laboratory for even a considerable time will not give correct results regarding the effects of the plating. The liquid does not come in contact with the un-

plated top. In transportation by railroad or truck much shaking will occur and boxes may be packed so as to invert the cans they contain. The slightly higher aldehyde content indicated in sample No. 3 may have been due to the long distance it had been transported into this market.

We desire to thank The Philadelphia College of Pharmacy and Science for permission to use the laboratory equipment in this investigation.

SUMMARY

Disturbance in ether anesthesia may be due to improper methods of administration or special susceptibilities, systemic or local. Aldehydes may be present in small amount even in the best grades, but are hardly likely to produce serious results. Peroxides are of infrequent occurrence.

Ordinary tin containers favor the production of aldehydes. In hospital practice all packages so furnished should be at once transferred to amber-glass bottles, well corked and kept in a cool dark place.

Fuchsin-sulphurous acid, especially when prepared according to Fincke's formula, is a delicate test for aldehydes—much more convenient than that recommended by U.S.P.X. It may be necessary, however, to fix a toleration limit for practical control. The chromic acid test for peroxides is also very delicate and more convenient than that recommended in U.S.P.X. In both these tests the reagent should be poured *through* the sample to be tested.

All packages of anesthetic ether should bear on the label in conspicuous figures the date of packing.

Henry Leffmann Chemistry Research Fund
Wagner Free Institute of Science of Philadelphia.

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BULLETIN

of the

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PUBLISHED BY THE INSTITUTE

Edited by the Publication Committee

WM. OTIS SAWTELLE HENRY LEFFMANN
SAMUEL TOBIAS WAGNER, *Ex-officio*

Vol. 5	Quarterly	$1.00 per year
No. 2	May, 1930	Single numbers, 25 cents

ANNOUNCEMENTS

THE regular instruction courses for the Spring Term were carried out according to schedule, with excellent attendance. On April 4 a lecture under the Fannie Frank Leffmann Memorial Lectureship foundation was given by Mr. Dan McCowan, of Banff, Canada, entitled, "A Naturalist in the Canadian Rockies." The attendance was very large and the lecture received with much enthusiasm.

The formal closing exercises for the session of 1929–30 were held on May 7. After a brief introductory address by Dr. Samuel C. Schmucker, Dean of the Faculty, the certificates of proficiency were awarded, and the exercises closed by an illustrated lecture by Dr. Herbert J. Spinden, Curator of Ethnology, Brooklyn Museum, on "The Ruined Cities of the Mayas." A large audience was present.

The annual Announcement giving information as to all the educational activities of the Institute will be sent on request. Further inquiries should be made at the office, which is open from 9 A.M. to 5 P.M. and 7 P.M. to 9 P.M., on all business days.

Entered as second-class matter, September 10, 1926, at the Post Office, Philadelphia, Pa., under Act of August 24, 1912.

INSTITUTE NEWS AND NOTES

The thorough revision of the Synoptical Collection of the larger groups of the Animal Kingdom begun last December has been completed. About 100 descriptive labels have been written and 75 colored drawings giving internal structures have been made. New specimens have been added and the whole collection brought up to date both as to classification and description.

The mounting of fishes presents one of the most difficult problems in the preparation of Museum exhibits. As an experiment the paraffin infiltration method was tried on a Half Moon fish (*Pterophyllum scolare*). The results obtained were very encouraging and further experiments will be carried on in this method of preparation as applied to fishes.

One of the noteworthy additions to the collection in the Museum is a group illustrating the large brown bat (*Vespertilio fuscus* Beau).

Several investigations have been made under the Henry Leffmann Chemistry Research Fund, among which are:

Studies of tests for acetone and aldehydes. Studies of tests for methanol and isopropanol, the latter being a recent introduction as a substitute for ordinary alcohol and, therefore, liable to be used as an adulterant.

Investigations as to the quality of commercial ether, especially to ascertain the presence of aldehydes and peroxides, some interest in these impurities having been aroused in medical and pharmaceutic circles from suspicion that they may cause trouble in the respiratory system. For publication of these investigations, the BULLETIN has been a ready and convenient medium.

A SYNOPSIS OF THREE LECTURES ON PRESENT PROBLEMS OF EVOLUTION

Delivered under the

RICHARD B. WESTBROOK FREE LECTURESHIP

Wagner Free Institute of Science, March 1, 8, 15, 1930

By Edwin Grant Conklin, Ph.D., Sc.D., LL.D.
Henry Fairfield Osborn Professor of Biology, Princeton University

I

In this series we will assume the truth of evolution, which stands fast in the minds of scientists. None the less there are many problems, especially concerning the factors which have brought about this evolution. On this point we must keep an open mind. There are doubtless many such causes, some of which are known, but we need a new Darwin to bring in a unifying idea.

We have come to realize that evolution is now going on, and that only continued and far-reaching observation and comparison of several generations of animals will give us the data we need. Darwin's great work after the "Origin of Species" concerned itself with the variation in animals or plants of the same species under domestication, and many studies have since been made of variations in wild animals. The snails of the genus Io on the upper Tennessee River are very unlike in different portions of the course. Tree snails of the genus Liguus show similar variations. While we know with great probability the wild ancestors of many of our cultivated plants, the early forms of most of our domesticated animals have either disappeared or the change has been so great that we cannot now be sure of their connection with the present forms.

The method by which characteristics are passed from parent to offspring doubtless exemplifies on a small scale the process of evolution. The same process in a longer series of generations must bring about the larger variations which we recognize in different species, genera, families, orders and phyla.

The recapitulation theory was for a while in evil repute. Now, however, we realize that while the embryonic development of the individual (ontogeny) pursues a hastened and direct course, and is modified in many ways to fit the conditions of life of the egg or larva, it none the less helps us to understand the more tortuous path of the evolution of the family line (phylogeny) through the ages.

We made many mistakes in the past by supposing that the adult form of one generation reproduces the adult form of the next. Now

we know that whatever change is inherited is a change in the germ line itself, and probably is not at all, or at most but very faintly, affected by alterations in the development of the body cells. The adult form owes its characters to the combined effect of heredity, environment and training. But it is only, or at least almost only, heredity which can affect the next generation.

II

Heredity determines then the possibilities; environment decides how fully these possibilities shall come to fruition.

DeVries first taught us to discriminate clearly between different types of variations—between those due to environment (fluctuations) and those resulting from changes in the hereditary plasm (mutations). Weismann's demonstration of the continuity of the germ plasm through successive generations gave the real clue to the materials by which inheritance is effected. It is our knowledge of the demonstrated course of this orderly process that has forced us to realize that changes in the adult form, brought about by changes in the environment, have no way, at present understandable, by which they can reproduce themselves in the germ cells. Hence we see no method by which such changes can be inherited.

The discovery of the structure of the chromosomes, yielded chiefly as the result of a wonderful series of studies on the fruit fly (Drosophila), has remarkably assisted our understanding of many changes. Morgan and his associates found about four hundred mutations of this minute insect, where successive generations may follow each other within twelve days. Careful study of thousands of cases of such mutations have made it possible for him and his followers to map out the actual location, in each of the four chromosomes of this insect, of the individual units (genes) which determine the characters of the developed adult.

The recognition of the relation of a particular pair of small chromosomes to the determination of sex has done much to help us understand the importance of the study of chromosome structure and activity.

Experiments are now going on to determine in how far it is possible to modify the germ plasm as it lies within the body of the adult. Muller found he could alter the later progeny by subjecting the parents to the action of x-rays, and that the alterations so produced were permanent in the later generations of the affected animals. Subsequently it was found that radium might produce similar effects.

Pollen from the tobacco plant, treated with x-rays and subse-

quently used to fertilize the ovules of another tobacco plant, brought about the formation of seeds whose later growth showed much alteration; and these changes were inherited in later plantings. Mice, similarly treated, gave greatly altered progeny, even to the entire absence of important organs.

Most mutations are injurious, and the new line cannot continue long when left to care for itself. A few, however, are distinctly advantageous, and here there is hope for future new lines.

III

In no respect is nature more remarkable than in the marvelous adaptations seen on every side. Indeed, to live means to be adaptable.

These adjustments are of two kinds. The first group consists of those which pass on from generation to generation. The human eye is an example of such. Developing in the dark, it is made for the light. The human muscles bring into effective use a larger proportion of the energy that goes into them in the shape of food, than any engine has yet extracted from its fuel. The human heart continues its uninterrupted throbbing, often for seventy years and sometimes for much longer. No machine made by man can run so long without repair.

Adaptations for defense are most varied. The mechanism by which the rattlesnake wards off its enemies is very complicated. Camouflages more effective than any of man's devising are shown by many animals. Even the smoke screen is duplicated in the ink cloud of the squid.

The modern microscope discloses minute adjustments no less remarkable. The relation between the sperm and the egg in fertilization, and the division of the hereditary units in mitosis, are complicated beyond man's most fertile constructive imagination to invent.

The chemist has not yet fathomed the subtle action of the ductless glands and of their secreted hormones.

The human individual, within his own lifetime, has marvelous powers of adjustment to external conditions. The skin, which suddenly exposed to bright sunlight burns and blisters, can, if gradually exposed, build for itself a pigment coat whose tan color acts as an effective screen against the deleterious effects of the powerful ultraviolet ray. The hand, gradually applied to rough work, covers itself with protective callouses. The muscles gain in strength through use. Immunity may be slowly acquired against germ or poison.

To simply attribute such delicacy of adaptation to the benevolence

of an Almighty Power is to side-step the question. Only two real explanations have been seriously offered by those familiar with science.

Lamarck suggested that each generation handed to the next the adaptations it had acquired; thus, adding its own acqusitions to those it had inherited, this process, running through many generations, seemed to him to account for the wonderful mechanisms finally possessed. Unfortunately, no entirely convincing evidence of such transmission of acquired characters has ever been adduced.

Darwin's classic explanation remains today the most satisfactory we have yet learned. There are, in each generation, far more individuals produced than can possibly survive. Each differs from every other offspring, even of the same parents. Here we find variations, however caused, extending in all directions. The individuals who have favorable alterations live longer and produce more abundantly. Those whose inheritances fit less accurately into the environment, pass quickly from the scene. By this process of constant selection of the fitted, and even more thorough elimination of the unfitted, increasing adaptation of each generation is effected.

This explanation is not without its difficulties, but it is much the best we have thus far had. It is the crowning glory of Darwinism.

Synopsis prepared by Dr. Schmucker and
reviewed by Dr. Conklin.

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OF THE

WAGNER FREE INSTITUTE OF SCIENCE

OF

PHILADELPHIA

VOLUME V, NO. 3, AUGUST, 1930

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FOR

SESSION OF 1930-31

EIGHTY-THIRD YEAR

WAGNER FREE INSTITUTE OF SCIENCE OF PHILADELPHIA

SEVENTEENTH STREET AND MONTGOMERY AVENUE

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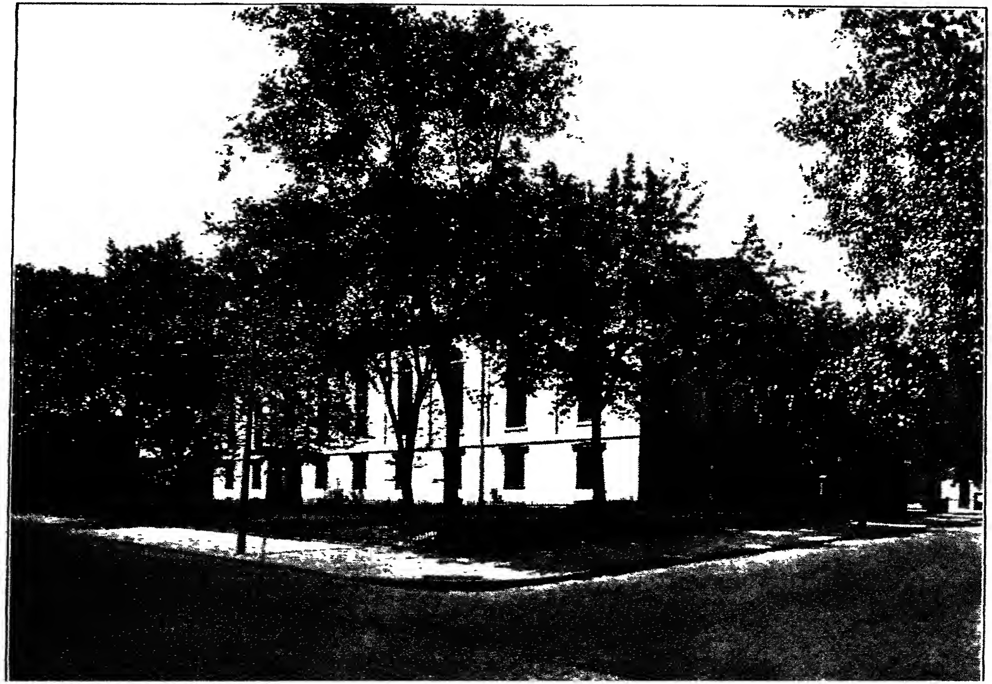

THE WAGNER FREE INSTITUTE OF SCIENCE
Montgomery Ave. and Seventeenth St.

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PUBLISHED BY THE INSTITUTE

Edited by the Publication Committee

WM. OTIS SAWTELLE HENRY LEFFMANN
SAMUEL TOBIAS WAGNER, *Ex-officio*

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WAGNER FREE INSTITUTE OF SCIENCE

Montgomery Ave. and Seventeenth St., Philadelphia, Pa., U. S. A.

HISTORICAL NOTE

The Wagner Free Institute of Science owes its establishment to the liberality and public spirit of William Wagner and his wife, Louisa Binney Wagner. In his early life Professor Wagner made extensive voyages in the service of Stephen Girard, and had opportunities to visit scientific institutions and make the acquaintance of scientific workers. He soon developed a strong interest in the natural sciences, especially geology and mineralogy, and devoted a large part of his life to studying these topics and collecting material to illustrate the teaching of them.

In 1847 he began to give free lectures at his home, near the present location of the Institute building, at that time in the rural section of the county. In 1855 the Institute was incorporated by the Legislature, a faculty was appointed and lectures were given at Commissioners' Hall, Thirteenth and Spring Garden Streets, by permission of the city authorities. In a few years the city was obliged, by its own needs, to withdraw the privilege of the hall, and Professor Wagner arranged to erect a suitable building on his own property. This was completed in May, 1865, and lectures at once given in it. In 1864 a deed of trust was executed by Professor Wagner and his wife, furnishing a permanent endowment of the Institute.

In 1885, by the death of the founder, the care of the Institute passed into the hands of a Board of Trustees, since which time many improvements have been made in the building, and extensive additions to the equipment in the museum and library and in scientific apparatus. In 1901 a wing was built for the use of a branch of the Free Library of Philadelphia.

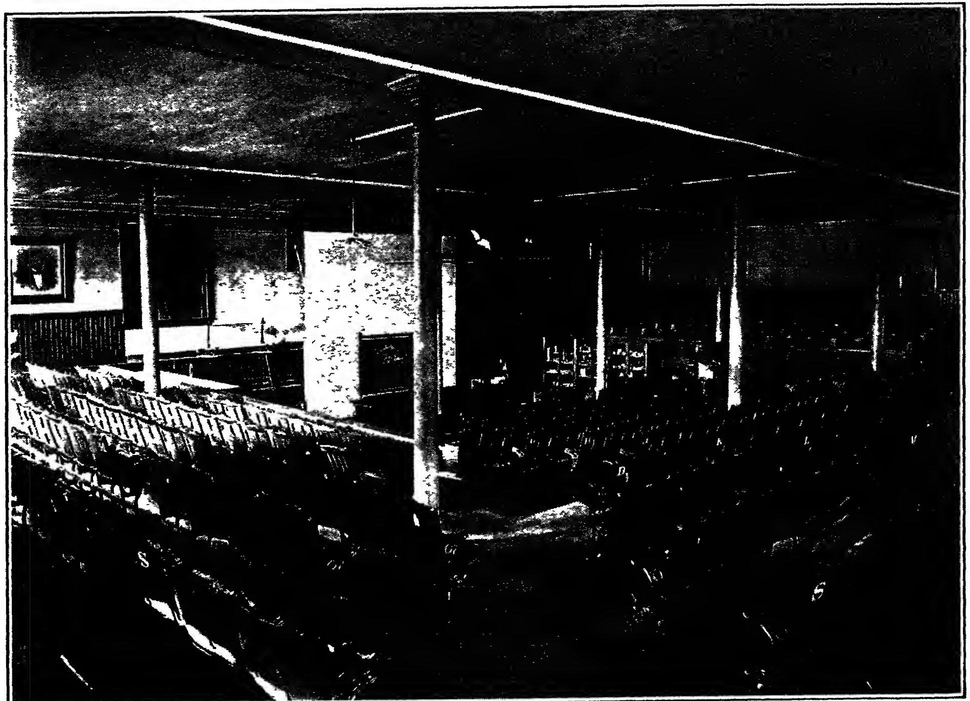
FACILITIES FOR INSTRUCTION

Lectures and Class-Work

Instruction at the Wagner Free Institute of Science is conducted by means of public lectures, supplemented by class-work, and is without charge and without restriction of race or sex. The class-instruction is given partly at the close of each lecture, partly by written exercises. The Museum and Reference Library of the Institute are available for aid in the instruction work and are freely used. In addition, the Wagner Free Institute Branch of the Free Library of Philadelphia affords abundant opportunities for collateral reading.

The lecture-hall is provided with the latest apparatus for lantern-slide and opaque projection.

At the close of each course of lectures an examination is held, to which those who have attended the classes are admitted, and on



Auditorium

MUSEUM

passing such examination the pupil is awarded a certificate. Certificates are awarded at a public meeting held in May of each year.

The lecture courses are arranged to cover a given topic in four successive years, and to those who hold certificates for each of these courses a full-term certificate is issued.

Museum

The Museum covers the whole field of natural science and contains illustrations in all departments of biology, geology, mineralogy, metallurgy, and engineering. The specimens are arranged so as to be easily studied and are open to inspection from 2 to 5 o'clock Wednesday and Saturday afternoons, except legal holidays.

Teachers with classes and others desiring to use the museum for special studies can, by applying at the office, gain admission any week-day, except holidays, as above stated, between the hours of 9 A. M. and 5 P. M.

The collections of the museum have been used for a number of years for instruction by means of "Museum Talks," as noted below, and by arrangement with work at Temple University and the Division of Science Teaching of the Board of Public Education those teaching General Science in the eighth and ninth grades of the Philadelphia public schools or preparing for such teaching may secure elective credits upon the completion of the work as follows:

General Science II

Monday,	7 P. M. to 8 P. M.	Museum Lecture.
	8 P. M. to 9 P. M.	Lecture Course—Botany and Zoology.

NOTE: Four semester hours of credit will be given for the complete Monday evening program.

Tuesday,	8 P. M. to 9 P. M.	Lecture Course—Inorganic Chemistry and Geology.
Wednesday,	8 P. M. to 9 P. M.	Lecture Course—Organic Chemistry and Physics.

NOTE: An additional two semester hours of credit per evening may be obtained by electing Tuesday or Wednesday evening.

Monday evening is a prerequisite for these, however.

Further information concerning these courses may be obtained at the Office of the Institute.

Libraries

The Reference Library contains text-books and works of reference in all departments of science, encyclopedias, many works devoted to literature, and an assortment of dictionaries of English, classical

and foreign languages. It is open on all regular business days from 9 A. M. to 9 P. M., a librarian being in attendance to assist students.

The Circulating Library is a branch of the Free Library of Philadelphia. It is open every business day from 9 A. M. to 9 P. M. Books may be taken out under the usual rules of the Free Library. Many periodicals—American and foreign, scientific and literary—are on file.

BULLETIN

The BULLETIN of the Institute is quarterly. It contains information as to the methods of work of the Institute, announcements of additions to its collections and original contributions to science. The fifth volume is now in course of publication. The subscription price is $1.00 per year, single copies, 25 cents.

SPECIAL LECTURES

By the liberality of Richard Brodhead Westbrook, D.D., for many years a trustee of the Institute, and of his wife, Henrietta Payne Westbrook, provision has been made for lectures independent of the general courses of the Institute and covering a wide range of topics. A list of lectures so far given and of publications thereof so far as issued is printed on second page of cover

Announcement of the course for 1931 will be made in a subsequent issue of the BULLETIN.

The income of a fund given by Dr. Henry Leffmann is applied to providing special lectures as the Fannie Frank Leffmann Memorial Lectureship. During the session of 1929–30 two lectures were given under this foundation, the first by Dr. Howard McClenahan, Secretary of the Franklin Institute, on a "Great Scientific Museum for Philadelphia"; the second by Dan McCowan of Banff, Canada, on "A Naturalist in the Canadian Rockies."

The *Philadelphia Natural History Society* meets on the third Thursday of each month, except June, July and August. These meetings are open to all persons interested in the subjects.

RESEARCH

The Institute has carried on research work since 1885, most of the results having been published in its Transactions and Publications. A list of these will be found on the fourth cover page. Results of research appear also from time to time in the BULLETIN.

The Henry Leffmann Chemistry Research Fund has been established for perpetual service. During the session of 1929–30 results of several special researches were published in the BULLETIN of the Institute.

CLOSING EXERCISES

In May of each year the courses of instruction are formally closed by a public meeting at which addresses are given and the certificates awarded.

At the closing exercises in May, 1930, after an address by Professor Samuel C. Schmucker, Dean of the Faculty, and awarding of certificates, Dr. Herbert J. Spinden, Curator of Ethnology of the Brooklyn Museum delivered a lecture entitled "Ruined Cities of the Mayas."

FULL TERM CERTIFICATES AWARDED

ENGINEERING	ZOOLOGY	PHYSICS
Monroe P. Lesher	William Gillette	William Gillette

1929–1930 CERTIFICATES AWARDED

ENGINEERING 3

Robert B. Bowman
Henry V. Deppisch
Alfred W. Fischer
Paul W. Gehris
Chauncey R. Kay
John J. Kyle
Monroe P. Lesher
Arthur N. Lind
Harry Tubis
John Young

BOTANY 3

Walter Gardner
Emanuel Hocking
Harry A. Lloyd
Florence McIlravey
Henry C. Savage
Herbert F. Schearer
Mrs. W. E. Toner

INORGANIC CHEMISTRY 1

Frederick Breida
David Chapman
Oscar Chernofsky
H. L. Grabosky
John G. Hope
Seymour Kety
Sophie Lerner
E. J. McBride
Reginald W. Owens

ORGANIC CHEMISTRY 1

Marguerite Dickey
A. Ceder Falke
J. Oakley Hendry
Clive A. Henninger
Frank P. Ingenito
B. S. Johnson
Sarah Lerner
Laird B. McLean
Reginald W. Owens
Louis B. Seiden
Leon E. Tull
Morgan L. West

ZOOLOGY 2

Winifred L. Bardsley
Ray Downey
Walter F. Estlack
Harry W. Fisher
William Gillette
Florian S. Herrmann
Emanuel Hocking
Frank P. Ingenito
Edwin J. McBride
Florence McIlravey
Bertha Mueller
G. R. Peffer
Henry C. Savage
Ida R. Strohlein
William Williams
Mrs. K. Eleanor Wignall

GEOLOGY 3

Mary Bullock
William Gillette
Mrs. Katharine R. Guest
William Heck
Florian S. Herrmann
John G. Hope
Clifton V. Mimms
Mrs. Reba A. G. Mimms
Henry C. Savage
Ellis E. Stineman
Henry Winsor

PHYSICS 4

Paul Collins
Joseph W. Conard
J. S. Cooper
William Gillette
H. L. Grabosky
Clive A. Henninger
Frank P. Ingenito
Edwin J. McBride
William A. Shrenk
James Q. Simmons, Jr.
William Williams

REGULAR LECTURES, SESSION OF 1930–1931

CIVIL ENGINEERING 4

PROFESSOR WAGNER

Water Supply, Sewers, Canals, Rivers and Harbors

Lectures begin at 8 P. M.

1. Friday, September 19.
   Hydrography. Water surveys of all kinds. Soundings. Discharge of streams. Current meters.
2. Friday, September 26.
   Water Supply. Water and its impurities. Analysis—chemical and biologic. Interpretation of analyses.
3. Friday, October 3.
   Water Supply (Continued). Sources of water. Consumption. Meters. Storage reservoirs.
4. Friday, October 10.
   Water Supply (Continued). Construction of reservoirs and dams of earth and masonry. Distributing systems. Aqueducts. Pipes.
5. Friday, October 17.
   Water Supply (Continued). Purification. Distilling. Boiling. Disinfection. Sedimentation. Filtration. Softening. Straining.
6. Friday, October 24.
   Water Supply (Concluded). Rapid and slow sand filters—their design and construction. Reduction of typhoid by filtration.
7. Friday, October 31.
   Sewers. Definitions. Sewerage systems. Requirements of a good system.
8. Friday, November 7
   Sewers (Continued). Location. Determination of amount of sewage and storm water. Formulæ.
9. Friday, November 14.
   Sewers (Continued). Size. Construction. Excavation and refilling.
10. Friday, November 21
    Sewers (Concluded). Disposition. Processes for purification. Disposal of sludge.
11. Friday, November 28.
    Canals. Classification. History. Cross-section. Water supply. Reservoirs. Feeders.
12. Friday, December 5.
    Canals (Concluded). Levels. Locks. Locomotion. Ship canals. Notable canals.
13. Friday, December 12.
    Rivers. Natural features. Protection of banks. Bars. Inundations. Regulation. Slack water navigation.
14. Friday, December 19.
    Harbors. Roadsteads. Harbors, Natural, Artificial. Dikes. Sea walls. Breakwaters.

INORGANIC CHEMISTRY 2

PROFESSOR HORN

Descriptive Chemistry

Lectures begin at 7.45 P. M.*

1. Tuesday, September 16.
   Chlorin. Occurrence, preparation, properties. Industrial uses. Isotopy. Liquefaction.
2. Tuesday, September 23.
   Chlorin Compounds. Polyvalence of chlorin. Acids of chlorin, and their salts. Modern atomic weight determinations.
3. Tuesday, September 30.
   Bromin, Iodin, Fluorin. Occurrence, preparation, properties. Halogen hydrids and oxids. General chemistry of the halogens. Halogen halids.
4. Tuesday, October 7.
   Physical-Chemical Equilibrium. The law of mass action. The phase rule. Transition points.
5. Tuesday, October 14.
   Sulphur. Occurrence, preparation, properties. Polymorphism. Molecular weight of sulphur. Sulphur chlorids. Sulphur hydrid. Sulphur dioxid.
6. Tuesday, October 21.
   Sulphur Trioxid. Preparation, properties, uses. Principal sulphur acids. Commercial catalysis. Desmotropism. Persulphates. Caro's acid.
7. Tuesday, October 28.
   Selenium, Molybdenum, Vanadium. Photo-chemical effects. Composition of polyacids as exceptions to "Definite Proportions." Discovery of elements consequent upon difficulties in mineral analyses. Vanadium in steels.
8. Tuesday, November 4.
   Nitrogen. Occurrence, preparation, properties. Fixation of nitrogen. Nitrogen hydrids.
9. Tuesday, November 11.
   The Atmosphere. Chemical composition. The noble gases and their uses. Fresh and vitiated air. Air poisons.
10. Tuesday, November 18.
    Oxids of Nitrogen. Nitric, nitrous and hyponitrous acids. Other hydroxids of nitrogen. Nitrogen halids.
11. Tuesday, November 25.
    Phosphorus. Sources, preparation, properties. Allotropism. Phosphorus hydrids, halids, and sulphids. Matches.
12. Tuesday, December 2.
    Oxids of Phosphorus. Phosphoric acid and its salts. Biologic importance of phosphates, and of phosphorus. The meta-phosphoric acids. Hydroxids of phosphorus, and other phosphorus acids.
13. Tuesday, December 9.
    Arsenic and Boron. Sources, preparation, properties. Applications. Oxygen and sulphur acids of arsenic. The boric acids.

*Please note the hour.

14. Tuesday, December 16.
Scandium, Gallium, Germanium, Indium, Beryllium. Chemical systematics and prophesies based thereupon. Laws of isomorphism, and of specific heat.

ORGANIC CHEMISTRY 2

PROFESSOR GRIFFITH

Carbohydrates, Fats, Oils and Waxes

Lectures begin at 8 P. M.

1. Wednesday, September 17.
Cellulose—At Home in Plant Structures. Its nature and chemical behavior.
2. Wednesday, September 24.
Cellulose in Service. Texts and Textiles. Paper, parchment, cotton, linen, ramie, cork, coir, kapok, etc.
3. Wednesday, October 1.
Chemicalized Cellulose. Demurę (rayon, celanese) and devil (guncotton).
4. Wednesday, October 8.
Starch—From the Storehouses of the Energy-Binders. Its nature, distribution and chemical eccentricities.
5. Wednesday, October 15.
Starch (Concluded). Physical properties of starch. Its role in plant and animal metabolism.
6. Wednesday, October 22.
The Sugars. Occurrence in nature. Physical and chemical family traits. The sweet quartette—sucrose, lactose, dextrose and maltose.
7. Wednesday, October 29.
Oils, Fats and Waxes. Proximate principles. Fixed oils and volatile oils. Oils that will—and oils that will not—saponify. Hydrogenated oils.
8. Wednesday, November 5.
Oils, Fats and Waxes (Continued). General properties, Origins. Preparation. Uses.
9. Wednesday, November 12.
The Non-Drying Oils. Cottonseed, olive, almond, peanut, corn, castor, etc.
10. Wednesday, November 19.
The Drying Oils. Linseed, hemp, poppyseed, soya, tung, fish oils, etc.
11. Wednesday, November 26.
Fats and Waxes, Vegetable and Animal. Cacao butter, palm oil, lard, tallow and wool fat, beeswax, carnauba wax, etc.
12. Wednesday, December 3.
Soaps. Saponification, composition and classification of soaps. Soap hokum.
13. Wednesday, December 10.
Milk and Its Ilk. Butter, cheese, cream, etc. Oleomargarine and butter substitutes. Household tests and legal standards.
14. Wednesday, December 17.
Milk and Its Ilk (Concluded). Milk and metabolism. Casein and casein products. Billiard balls and bureaus made of milk.

BOTANY 4

PROFESSOR KAISER

Physiology and Ecology

Lectures begin at 8 P. M.

1. Monday, September 15.
   Physiology. The physics and chemistry of plant life. Conditions of growth. Metabolism: the processes of nutrition. Constituents of the plant body, the elements that it requires and how they are obtained.
2. Monday, September 22.
   Photosynthesis. The assimilation of carbon from the air. The dependence of terrestrial life upon chlorophyll. The building up of carbohydrates. Enzymes and their uses. Chemisynthesis.
3. Monday, September 29.
   Assimilation of Nitrogen. Special processes of nutrition in parasites, saprophytes and symbionts. Nitro-bacteria. Mycorrhiza. Carnivorous plants. Myrmecophytes or ant plants.
4. Monday, October 6.
   Respiration. The breathing of plants. Comparison with photosynthesis. Production of heat and phosphorescence with examples. Fermentation. Growth and development. The three phases according to Sachs. Longevity of trees.

No lecture October 13.

5. Monday, October 20.
   Autonomic movements in plants. The rotation, circulation and streaming of protoplasm within walled cells. Peculiar motions of diatoms and desmids. Phototaxis. The opening of flowers and construction of floral clocks and calendars.
6. Monday, October 27.
   Paratonic movements in plants caused by various stimuli. Phototropism and geotropism: influences of the sun and gravity. Other tropisms. Nastic movements. The sleep of plants.
7. Monday, November 3.
   Reproduction: vegetative and sexual. Pollination by wind, insects, birds, snails, bats and water. The fruit and the many ways in which it may be disseminated.
8. Monday, November 10.
   Ecology. Plant distribution in relation to environment. The zones of the earth and their vegetation. The all-importance of moisture upon the nature of floras. Succession of plants in geologic time.
9. Monday, November 17.
   North Temperate Zone. The varied plant groupings of North America. Coastal plain. Sand dunes and pine barrens. Gulf states. Lake shores and river valleys. Prairies, forests and mountains. Grassland and desert. Pacific Coast.
10. Monday, November 24.
    North Temperate Zone (Continued). Europe and the Alps. British Isles. The Mediterranean region. Asia and Japan. The Himalayan flora. The steppes of Russia. The Atlantic Islands.

11. Monday, December 1.
    Tropics of the Old World. The heart of Africa. Continental Asia, including India, by many considered the cradle of the human race. Remarkable plants and luscious fruits of Malaya and Polynesia.

12. Monday, December 8.
    Tropics of the New World. Mexico and Central America. The obvious cactus. Islands of the West Indies and their rich flora. Trinidad. The virgin forest of Brazil.

13. Monday, December 15.
    South Temperate Zone. Characteristic plants of South Africa. The wonderful flora of Australia. New Zealand: the land of ferns and unusual trees. Fuegia and Chile. The Cape Horn region. Gondwana Land.

14. Monday, December 22.
    Plants in Relation to Man. His destructiveness and constructiveness considered. The influence of man on evolution. Plant breeding. Natural and methodical selection. Variation, mutation, heredity, hybridization. Weeds. General conclusions.

ZOOLOGY 3

PROFESSOR SCHMUCKER

Man: His Origin, Development and Structure

Lectures begin at 8 P. M.

I. Man's Origin

1. Monday, January 5.
   Man and the Lower Animals. The great apes. The bones found in Java. The Piltdown discovery. How old is man?
2. Monday, January 12.
   Lowly Types of Men. The Heidelberg jaw. Neanderthal man: the earliest well known type.
3. Monday, January 19.
   Men of Our Own Type. The Dordogne valley. Cro-Magnon Man. His fine structure. His wonderful art. Whence did he come, and why?
4. Monday, January 26.
   The Polished-Stone Age. The shell mounds. The lake dwellings. The beginnings of agriculture, commerce, animal husbandry and metallurgy. Copper, bronze and iron.
5. Monday, February 2.
   Men of the Present. All of one species. The Asiatic home. The migrations. The black type, in the islands and in Africa. The yellow man and his red derivative. The white man and his altered color.
6. Monday, February 9.
   The American Melting Pot. The three types of white men. The Mediterranean strain. The Nordic offshoot. The Alpine wedge. Their transfer to America. Does man hybridize well?

II. The Development of the Individual

7. Monday, February 16.
Before Birth and During Infancy. Cell union and the nest. Climbing the family tree. The shock of arrival. The transition. Adjusting to the world.

No lecture February 23.

8. Monday, March 2.
Manhood and Womanhood. The glands and their hormones. The secondary sex characters. The mental difference.

9. Monday, March 9.
Life at its Best. In tune with nature's laws. The enemies: climate and adjustment to it; bacteria and immunity; fellow man, at home, the defective, the delinquent and the rival; abroad, race hatred and patriotism.

10. Monday, March 16.
The Decline of Life. Average life longer, but little added to the span. Child diseases fewer, but increase of heart and kidney troubles and of cancer. Growing old gracefully.

III. Man's Structure

11. Monday, March 23.
The Framework and its Clothing. The stiffening bone and cartilage. The binding sheath and the cords and straps. The working muscles and nerves.

12. Monday, March 30.
The Activity of the Organs. Taking in and placing fuel. Getting out its energy. Throwing away the drained material.

13. Monday, April 6.
Contact and Coordination. Nerve fibers and cells and their activities. The two great systems. Main offices and branch offices. Localization. Getting news from the outside.

14. Monday, April 13.
Safeguarding Life. Keeping fit physically. Avoiding contagion. Averting accident. Safeguarding sanity. Science and immortality.

PHYSICS 1

PROFESSOR SEELY

Matter, Measurement and Mechanics

Lectures begin at 8 P. M.

1. Wednesday, January 7.
Introduction. Physics defined. Matter and mass. Measurements of quantity, extension and mass. Metric and English units. States of matter. Time.

2. Wednesday, January 14.
Motion, Velocity and Acceleration. Rectilinear and curvilinear motions. Uniform and accelerated motions. Equations of motion. Simultaneous motions and velocities. Composition and resolution of motions and velocities.

3. Wednesday, January 21.
Newton's Laws of Motion. Force and momentum. First Law—inertia. Units of force. Second Law—acceleration. The equation and its development. Third Law—action and reaction.

4. Wednesday, January 28.
   Moments of Force. Forces producing rotation about a point. Parallel forces. The Couple. Concurrent and divergent forces. Composition and resolution of forces. Centripetal acceleration and circular motion.
5. Wednesday, February 4.
   Work and Energy. Potential and kinetic energy. Units of energy, work and power. Transformations and conservation of energy. Matter and energy related.
6. Wednesday, February 11.
   Gravitation. Newton's Law of Gravitation. Weight. Equilibrium and stability. Falling bodies.
7. Wednesday, February 18.
   Gravitation (Continued). Falling bodies further considered. Paths of projectiles. The pendulum.
8. Wednesday, February 25.
   Machines. Purposes of machines. Six elementary machines. Principle of work. Mechanical advantage. Efficiency.
9. Wednesday, March 4.
   Machines (Continued). Friction—waste of energy. Thrust and tension on rods. Tension on cords.
10. Wednesday, March 11.
    Liquids. Forces due to weight in liquids. Pressure in vessels of different shapes. Liquids in communicating vessels. Transmitted forces in liquid.
11. Wednesday, March 18.
    Liquids (Continued). Pascal's Law. The application of the law to hydraulic machines—presses, wells, elevators, etc. Archimedes Principle. Floating bodies. Specific gravities by this principle.
12. Wednesday, March 25.
    Liquids (Continued). Molecular forces in liquid. Cohesion and adhesion. Surface films. Surface tension. Capillary phenomena.
13. Wednesday, April 1.
    Gases. Weight and density of gases. Atmospheric pressure. Barometer. Weather maps. Expansibility and compressibility of gases.
14. Wednesday, April 8.
    Gases (Concluded). The gas laws. Nature and composition of atmosphere. Atmospheric density and buoyancy.

GEOLOGY 4

PROFESSOR HOWELL

Historical Geology

Lectures begin at 7.45 P. M.*

1. Tuesday, January 6.
   Mother Earth's Autobiography. How she wrote it and how we decipher it.
2. Tuesday, January 13.
   The Time-dimmed Pages of the Early Volumes. The difficulties we encounter in trying to read the charred and crumpled record of Archeozoic times.

* Please note the hour.

3. Tuesday, January 20.
   The Writing Becomes More Legible. The fragmentary story of the Proterozoic Era.
4. Tuesday, January 27.
   The First Illustrated Volume. How the Cambrian fossils give us a much clearer picture of the world of their day.
5. Tuesday, February 3.
   The Earth's Inhabitants Put on Armor. How the struggle for existence forced the inhabitants of the Ordovician seas to encase themselves in coats of mail.
6. Tuesday, February 10.
   The Invasion of the Dry Lands. How the plants and animals crossed the strand line in Silurian times.
7. Tuesday, February 17.
   The Devonian, Age of Armored Fishes. The vertebrates become lords of the waters.
8. Tuesday, February 24.
   The Carboniferous and its great Coal Swamps. The appearance of the first legged vertebrates and winged insects.
9. Tuesday, March 3.
   The Hard Times of the Permian Period. The great ice age which closed the Paleozoic Era.
10. Tuesday, March 10.
    The Triassic and the Beginning of the Age of Reptiles. The dinosaurs become lords of the lands.
11. Tuesday, March 17.
    The Jurassic Period and the First Birds. Archaeopteryx, the little feathered cousin of the dinosaurs.
12. Tuesday, March 24.
    The Cretaceous, Age of Chalk. The reptiles have their heyday and begin their long decline.
13. Tuesday, March 31.
    The Tertiary, Age of Mammals. The hairy vertebrates become the dominant creatures of the earth.
14. Tuesday, April 7.
    The Quaternary, and the Dominance of Man. The Pleistocene ice and the civilization which followed its retreat.

SERIES OF MUSEUM TALKS

Monday Evenings at 7 o'clock

Sept. 15. Great Groups of Plants—Slime Moulds............Professor Kaiser

Sept. 22. Worms—Earth Worms: Their Structure, Habits and Economic Importance to Man............................Mr. Lawrence

Sept. 29. Land Birds—Birds of Fields and Meadows: Meadowlark, Blackbirds, Bob-o-link....................................Miss Borden

Oct. 6. Great Groups of Plants—Blue-green Algæ..........Professor Kaiser

Oct. 13. No Lecture.

Oct. 20. Worms—Marine Worms: Many Forms and Strange Adaptations; Tube Building and Other Methods of Protection.....Mr. Lawrence

Oct. 27. Steps in Animal Evolution—Step 1: Learning Cooperation
Professor Schmucker

Nov. 3. Great Groups of Plants—Green Algæ and Algal Fungi
Professor Kaiser

Nov. 10. Land Birds—Birds of Wooded Areas and Shady Lawns: Woodpeckers, Cardinals, Thrushes, Tree Swallows..........Miss Borden

Nov. 17. Worms—Fresh Water Worms: Life Histories; Special Adaptations
Mr. Lawrence

Nov. 24. Steps in Animal Evolution—Step 2: Going Head Foremost
Professor Schmucker

Dec. 1. Great Groups of Plants—Brown and Red Algae......Professor Kaiser

Dec. 8. Land Birds—Birds of Orchard and Garden: Orioles, Robin, Flycatchers, Hummingbirds..........................Miss Borden

Dec. 15. Worms—Ascaris lumbricoides and Trichina spiralis, Two Dangerous Parasites of Man...............................Mr. Lawrence

Dec. 22. Steps in Animal Evolution—Step 3: Getting Sidetracked
Professor Schmucker

Dec. 29. No lecture

Jan. 5. Great Groups of Plants—Sac Fungi..............Professor Kaiser

Jan. 12. Land Birds—Birds Around Houses and Other Buildings: Sparrows, Chimney Swift, Martins, Swallows................Miss Borden

Jan. 19. Worms—Tape Worms: Structure, Habits, Method of Transfer from one Host to Another, Difficulty of Getting Rid of Them
Mr. Lawrence

Jan. 26. Steps in Animal Evolution—Step 4: A Rival Plan
Professor Schmucker

Feb. 2. Great Groups of Plants—Lichens................Professor Kaiser

Feb. 9. Land Birds—Birds of Prey: Owls, Hawks, Eagles, etc....Miss Borden

Feb. 16. Worms—Liver Fluke, Distomum hepaticum: Strange Life History, Effect Upon Man and Other Animals.............Mr. Lawrence

Feb. 23. No Lecture.

Mar. 2. Great Groups of Plants—Mushrooms and Their Kin..Professor Kaiser

Mar. 9. Land Birds—Game Birds: Grouse, Pheasant, Jungle-Fowl, Wild Turkey...Miss Borden

Mar. 16. Worms—The Hook Worm: How It Caused a Great Hygienic and Economic Problem in the South; How the Problem Has Been Solved.................................Mr. Lawrence

Mar. 23. Steps in Animal Evolution—Step 5: Getting a Backbone
Professor Schmucker

Mar. 30. Steps in Animal Evolution—Step 6: Leaving the Water
Professor Schmucker

Apr. 6. Great Groups of Plants—Mushrooms and Their Kin (Concluded)
Professor Kaiser

Apr. 13. Land Birds—Unusual Birds From Various Lands: Hammerhead, Kiwis, Bower-bird, Shoe-bill......................Miss Borden

Apr. 20. Worms—Worms in General as Parasites: Their Hosts and the Effects Produced upon Them. General Economic Importance of Worms.

Mr. Lawrence

Apr. 27. Steps in Animal Evolution—Step 7: Winning Warmth

Professor Schmucker

MUSEUM TALKS (By Topics)

Monday Evenings at 7 o'clock

Great Groups of Plants

Professor Kaiser

Sept. 15. Slime Moulds

Oct. 6. Blue-green Algæ

Nov. 3. Green Algæ and Algal Fungi

Dec. 1. Brown and Red Algæ

Jan. 5. Sac Fungi

Feb. 2. Lichens

Mar. 2. Mushrooms and Their Kin

Apr. 6. Mushrooms and Their Kin (Concluded)

Worms

Mr. Lawrence

Sept. 22. Earth Worms: Their Structure, Habits and Economic Importance to Man

Oct. 20. Marine Worms: Many Forms and Strange Adaptations; Tube Building and Other Methods of Protection

Nov. 17. Fresh Water Worms: Life Histories; Special Adaptations

Dec. 15. Ascaris lumbricoides and Trichina spiralis, Two Dangerous Parasites of Man

Jan. 19. Tape Worms: Structure, Habits, Method of Transfer From One Host to Another, Difficulty of Getting Rid of Them

Feb. 16. Liver Fluke, Distomum hepaticum: Strange Life History, Effect upon Man and Other Animals

Mar. 16. The Hook Worm; How it Caused a Great Hygienic and Economic Problem in the South; How the Problem has been Solved

Apr. 20. Worms in General as Parasites: Their Hosts and the Effects Produced upon Them. General Economic Importance of Worms

Land Birds

Miss Borden

Sept. 29. Birds of Fields and Meadows: Meadowlark, Blackbirds, Bob-o-link

Nov. 10. Birds of Wooded Areas and Shady Lawns: Woodpeckers, Cardinals, Thrushes, Tree Swallows

Dec. 8. Birds of Orchard and Garden: Orioles, Robin, Flycatchers, Hummingbirds

Jan. 12. Birds Around Houses and Other Buildings: Sparrows, Chimney Swift, Martins, Swallows

Feb. 9. Birds of Prey: Owls, Hawks, Eagles, etc.

Mar. 9. Game Birds: Grouse, Pheasant, Jungle-Fowl, Wild Turkey

Apr. 13. Unusual Birds From Various Lands: Hammerhead, Kiwis, Bower-bird, Shoe-bill

Steps in Animal Evolution

Professor Schmucker

Oct. 27. Step 1: Learning Cooperation

Nov. 24. Step 2: Going Head Foremost

Dec. 22. Step 3: Getting Sidetracked

Jan. 26. Step 4: A Rival Plan

Mar. 23. Step 5: Getting a Backbone

Mar. 30. Step 6: Leaving the Water

Apr. 27. Step 7: Winning Warmth

GENERAL SCHEDULE OF REGULAR LECTURES

Subjects of courses in each of the four successive years constituting a full term.

ENGINEERING

1. Materials of Engineering Construction.
2. Civil Engineering Structures.
3. Roads, Railroads and Tunnels.
4. Water Supply, Sewers, Canals, Rivers and Harbors.

PHYSICS

1. Properties of Matter. Mechanics.
2. Heat and Sound.
3. Light.
4. Electricity and Magnetism.

INORGANIC CHEMISTRY

1. General Principles, Notation, Nomenclature.
2. Descriptive Chemistry.
3. Descriptive Chemistry.
4. Descriptive Chemistry.

ORGANIC CHEMISTRY

1. General Principles, Aliphatic Hydrocarbons.
2. Carbohydrates, Fats, Oils and Waxes.
3. Cyclic Hydrocarbons.
4. Compounds Containing Nitrogen.

ZOOLOGY

1. Invertebrate Animals.
2. Vertebrate Animals.
3. Human Biology.
4. Principles of Animal Life.

BOTANY

1. Morphology.
2. Taxonomy.
3. Taxonomy (continued).
4. Physiology and Ecology.

GEOLOGY AND PALEONTOLOGY

1. Physical Geography.
2. Physical Geology.
3. Paleontology.
4. Historical Geology.

PUBLICATIONS OF THE INSTITUTE

TRANSACTIONS

Vol. 1.—Explorations on the West Coast of Florida and in the Okeechobee Wilderness. *Angelo Heilprin.* $2.50

Vol. 2.—Report on Fresh-water Sponges Collected in Florida. *Edward Potts.*
Notice of Some Fossil Human Bones. *Joseph Leidy.*
Description of Mammalian Remains from Rock Crevice in Florida. *Joseph Leidy.*
Description of Vertebrate Remains from Peace Creek, Florida. *Joseph Leidy.*
Notice of Some Mammalian Remains from Salt Mine of Petite Anse, Louisiana. *Joseph Leidy.*
On Platygonus, an Extinct Genus Allied to the Peccaries. *Joseph Leidy.*
Remarks on the Nature of Organic Species. *Joseph Leidy.* $1.00

Vol. 3.—Parts 1, 2, 3, 4, 5, 6.—Contributions to the Tertiary Fauna of Florida. *William H. Dall.* $15.75

Vol. 4.—Fossil Vertebrates from the Alachua Clays, Florida. *Joseph Leidy.* $1.25

Vol. 5.—Study of Hawaiian Skulls. *Harrison Allen.*
Notes on the Palæontological Publications of Prof. William Wagner. *William H. Dall.* $1.00

Vol. 6.—Selenodont Artiodactyls of the Uinta Eocene. *William B. Scott.* $1.00

Vol. 7.—Contributions to the Mineralogy of the Newark Group in Pennsylvania. *Edgar T. Wherry.*
A Comparative Study of the Radio-Active Minerals in the Collection of the Wagner Free Institute of Science. *Carl Boyer and Edgar T. Wherry.* $0.50
Vegetation of South Florida. *John W. Harshberger.* $2.50
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BULLETIN

Bulletin of the Institute. Quarterly $1.00 per year
Single numbers, 25 cents.

Republication of Conrad's Fossils of the Medial Tertiary of the United States. Introduction by *William H. Dall.* (Out of Print.)

BULLETIN

of the

WAGNER FREE INSTITUTE OF SCIENCE OF PHILADELPHIA

PUBLISHED BY THE INSTITUTE

Edited by the Publication Committee

WM. OTIS SAWTELLE — HENRY LEFFMANN
SAMUEL TOBIAS WAGNER, *Ex-officio*

Vol. 5	Quarterly	$1.00 per year
No. 4	November, 1930	Single numbers, 25 cents

ANNOUNCEMENTS

THE regular lecture season began September 15, and the attendance since that time has been very satisfactory.

The first lecture of the season under the Fannie Frank Leffmann Memorial Lectureship, delivered November 8 by Lester W. Strock, M.S., was entitled, "A Trip Across the Canadian Ice Fields." Mr. Strock traveled 500 miles by pack train from Seebe, Alberta, following the Continental Divide across the Columbian Ice Field. His lecture well illustrated the glaciers of the country and particularly emphasized the effect of altitude on the flora. The wild life of the region was also described.

A Special Lecture, "On Safari," by Dr. S. A. Barrett, is scheduled for Saturday, February 7, 1931. Dr. Barrett, Director of the Milwaukee Museum since 1920, has spent considerable time in Africa, and his lecture will consist of a series of intimate tales and incidents of African life. The lecture will be illustrated by motion pictures and lantern slides.

The annual Announcement giving information as to all the educational activities of the Institute will be sent on request. Further inquiries should be made at the office, which is open from 9 A.M. to 5 P.M. and 7 P.M. to 9 P.M., on all business days.

Entered as second-class matter, September 10, 1926, at the Post Office, Philadelphia, Pa., under Act of August 24, 1912.

INSTITUTE NEWS AND NOTES

During the summer a limonite geode, measuring 17 by 8 inches, and two notable calcites were among the additions to the mineral collection.

A specimen of liver fluke (Fasciola hepatica), a tape worm (Taenia pisiformis) and other specimens of worms were added to the collections and will be used by Mr. Lawrence in his series of Museum Talks.

Quite a number of specimens of mountain flora, collected by the Director and his Assistant in the Adirondacks and the White Mountains, have been added to the Herbarium.

A collection of 83 specimens of furs of different animals has been presented by Mr. Theodore F. Seifert.

During September, Mr. C. C. Pines, Assistant under the Henry Leffmann Research Fund, was engaged in investigations in the composition of commercial methanol, but the work is not yet ready for publication.

The subject and speaker for the 1931 Westbrook Free Lectureship Course have not yet been announced. Persons whose names are not already on the mailing list but who desire to receive notices of these lectures should notify the Institute.

Early in January the second volume of the PUBLICATIONS of the Institute, a book of about 420 pages on "Evolution in the Genus Spirifer," by Carroll Lane Fenton, will be issued.

[*Bulletin, Wagner Free Institute of Science, Philadelphia, November, 1930.*]

NOTES ON CRYSTAL ETCHINGS*

GEORGE T. FAUST

INTRODUCTION

The results of etch figure studies have been excellently treated by such authors as Baumhauer, Becke, Beckenkamp, Traube and Tschermak of the early period, and Honess, Walker, Daly, McNairn and others of the recent period of etch figure investigation. This paper presents the results of experimental work carried on in the investigation of the symmetry of unetched forms on crystals and of some minerals which have not been investigated previously with respect to their etching phenomena. It was expected that the results obtained would not be at variance with the established symmetry, a conclusion which was definitely confirmed by the solution studies.

The Etching Figures of Quartz

The fundamental forms on quartz have been etched by many investigators, but none of the workers, so far as the writer knows, has been successful in etching the trigonal pyramid s $(11\bar{2}1)$. This suggested the desirability of obtaining the additional data afforded by the etching phenomena of this rarer form; and for the sake of completeness, the etchings produced on the other forms present are included.

The mineral was etched with cold, concentrated hydrofluoric acid (C. P.), the results of which follow:

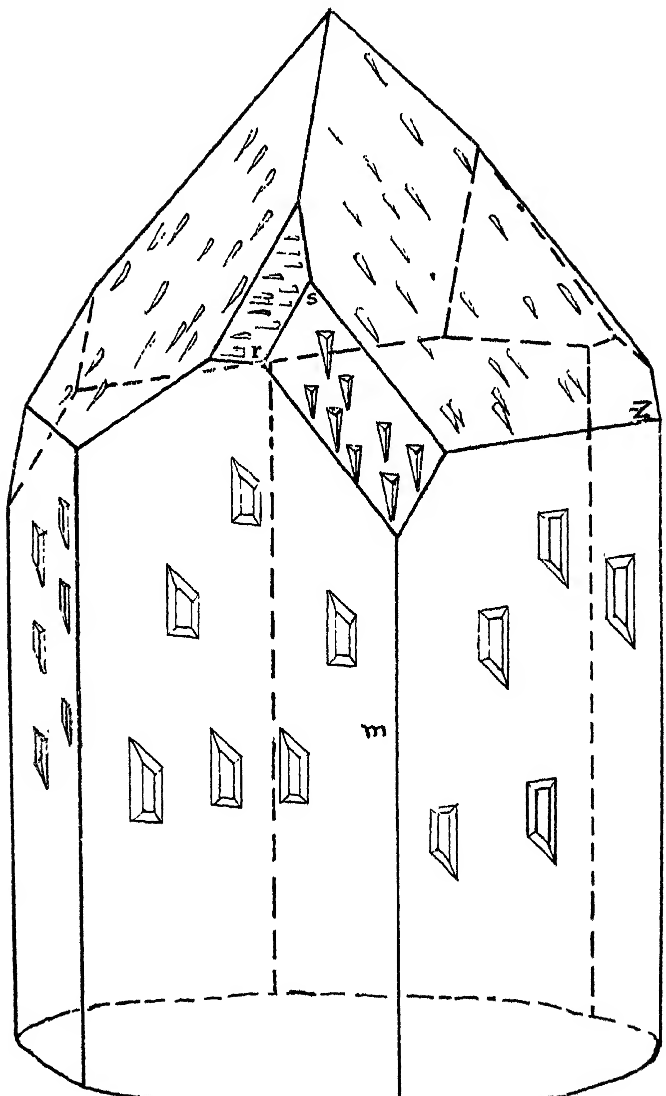
The First Order Prism m $(10\bar{1}0)$

Figures of this form were developed on the prism faces after twelve hours' immersion in the solvent. The pits are trapezoidal in shape and are not divisible by planes of symmetry. (See Plate I.) The etchings of the six prism faces are identical in the constitution of planes indicating the hexagonal forms; however, alternate faces only possess figures of like orientation, indicating the trigonal characteristic of the $\dot{c}$ axis. Further, since the figures are not symmetrical, no planes of symmetry pass through the center of

* A part of the thesis submitted in partial fulfillment for the degree of Bachelor of Science in the Pennsylvania State College, May 30, 1930.

the faces, and since the figures on adjacent faces are unlike in orientation the possibility of symmetry planes through the edges is precluded.

PLATE I



Quartz

The Trigonal Pyramid s $(11\bar{2}1)$

After an immersion period of eighteen minutes, the trigonal pyramid appeared striated parallel to the combination edge with the r rhombohedron. The crystal was returned to the liquid and after five hours' immersion it was noticed that the trigonal pyramid exhibited definite etching patterns. The mature figures have the outline of a scalene triangle, and are elongated in the direction of the $\overset{|}{c}$ axis. (See Plate I.) Therefore, the etchings are not symmetrical to symmetry planes, nor are the figures of adjacent trigonal pyramidal faces mirror images. On each of the trigonal pyramid faces the figures produced are alike, which indicates that the $\overset{|}{c}$ axis is one of trigonal symmetry.

The edges of the trigonal pyramid were corroded after another hour's immersion in the solvent and the face itself became deeply etched though still preserving the triangular outlines. Continued immersion to the extent of another hour and a quarter resulted in corroded surfaces bearing little evidence of former symmetry qualities.

The Rhombohedron z $(01\bar{1}1)$

The faces of the z rhombohedron were well developed and yielded good figures after three and a quarter hours' immersion in cold hydrofluoric acid. The etchings appear as triangular pits with the outer contour slightly curved. (See Plate I.) The z faces alternate above and below around the $\overset{|}{c}$ axis, and since the etchings on all of the z faces are alike, it indicates once more the trigonal symmetry of the $\overset{|}{c}$ axis. The figures are not divisible by any planes of symmetry, indicating an absence of reflection symmetry within the structure.

The Rhombohedron r $(10\bar{1}1)$

This form was definitely etched after an immersion period of six and one-half hours. The figures occurring on r $(10\bar{1}1)$ are similar to those on z $(01\bar{1}1)$ but differ in their orientation on the face, the mature figures of the former r $(10\bar{1}1)$ having one edge parallel to the intersection of the r rhombohedron and the prism. (Plate I.) The etchings on the r $(10\bar{1}1)$ are alike in the constitution of planes and in orientation, but are *asymmetrical*, and are not mirror images of one another when considering adjacent r faces. Taken together, the etchings of the six faces of this form indicate trigonal symmetry for the $\overset{|}{c}$ axis, a fact previously established by crystallographic evidence.

Summary

A study of the etch figures produced on the following forms s $(11\bar{2}1)$; m $(10\bar{1}0)$; z $(01\bar{1}1)$; r $(10\bar{1}1)$ of quartz indicates:

(1) That there are no planes of symmetry in quartz.
(2) That there is no center of symmetry.
(3) That the $\overset{|}{c}$ axis is a trigonal axis of symmetry.
(4) That the three horizontal axes are digonal axes of symmetry and that they emerge from the center of the edges and not of the faces.

From these data it is evident that quartz is a member of the trapezohedral class of the hexagonal system or the trigonal holoaxial of some writers. It is also to be observed that the etchings of the rarer form s establish a symmetry identical to that previously indicated by the etchings of the commoner forms.

The relative order of solubility of the forms etched with cold H F acid is s $(11\bar{2}1)$; r $(10\bar{1}1)$; z $(01\bar{1}1)$; and m $(10\bar{1}0)$, the trigonal pyramid being most soluble.

Further, the insolubility of certain faces seems to indicate that the distribution of etch figures on a crystal surface is probably due to surface irregularities.

The Etching Figures of Orthoclase

No data on the etching figures of orthoclase could be found in the literature, and since there was some clear gemmy material from Madagascar available it was decided to investigate the symmetry by the etching method.

In the absence of good crystals, cleavage pieces of orthoclase suitable for etching were chosen. These plates represent the (001) and (010) planes, and due to their exceptional smoothness proved excellent material upon which to work. A brief description of the results follows.

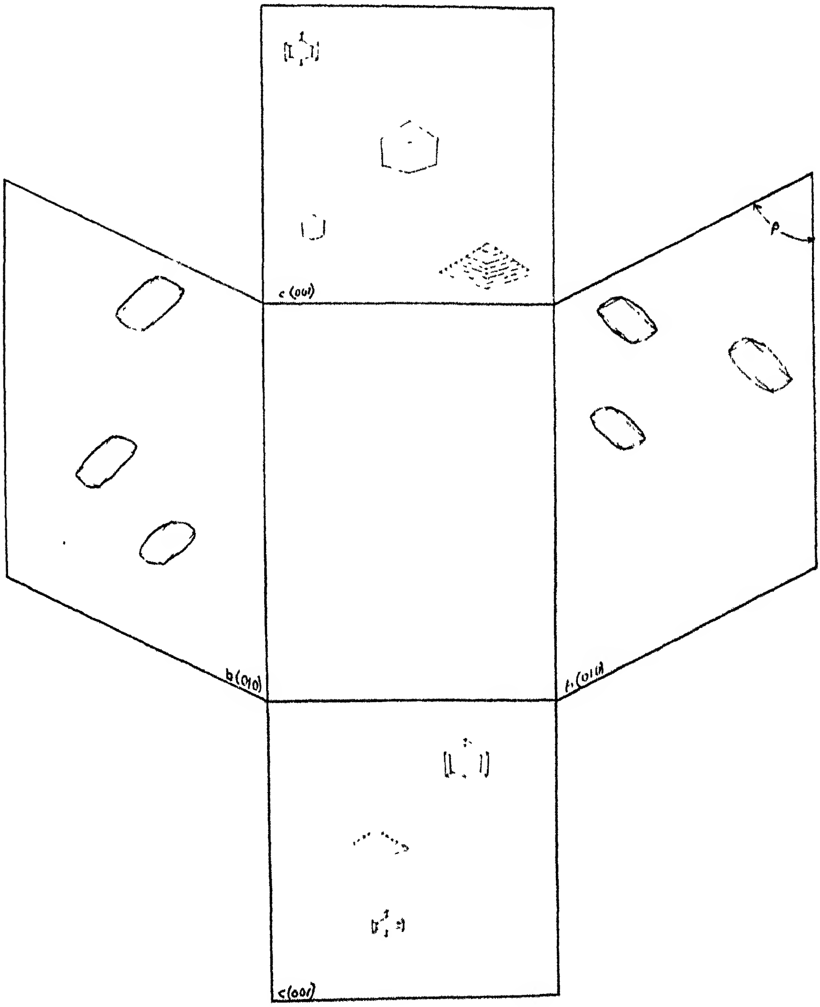
The Basal Cleavage (001)

With hydrofluoric acid

Good figures were obtained by immersing the cleavage fragment in cold hydrofluoric acid for ten seconds. The figures are six-sided when mature and show definitely one plane of symmetry. The etch figures are elongated parallel to the $\overset{\perp}{b}$ axis, thus indicating that the $\overset{\perp}{b}$ axis is the direction of maximum solubility for this form when cold hydrofluoric acid is employed as the solvent. If the fragments are held in the liquid for a longer period the figures appear three-sided and may be considered overdeveloped.

For the arrangement of the figures on the basal cleavage, see Plate II, which shows both the upper and the lower basal cleavage surfaces. From a study of the drawing it will be seen that if the

PLATE II



crystal plate be revolved about the $\overset{\perp}{b}$ axis 180° the figures on one of the basal surfaces will turn into congruence with those on the other. It is also evident from the drawing that the crystal possesses a center of symmetry.

PLATE III

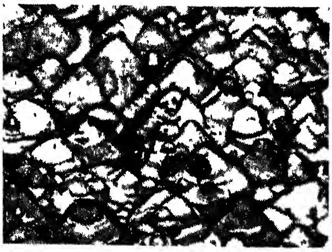


Fig. 1

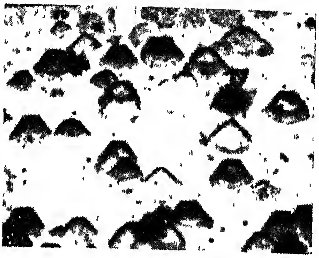


Fig. 2

Fig. 3

Fig. 4

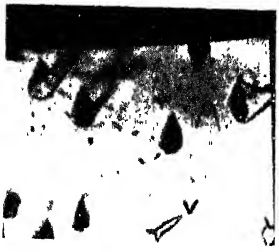


Fig. 5

Fig. 6

Fig. 7

With potassium hydroxide

The basal cleavage etches rapidly with the potassium hydroxide fusion and the figures produced are of the same type as those obtained by cold hydrofluoric acid, but they differ in that they are elongate in a direction parallel to the à axis. The figures exhibit one plane of symmetry, containing the à and c̀ crystallographical axis.

The direction of maximum solubility in the case of KOH is parallel to the à axis, a result unlike that obtained with HF.

The Clinopinacoidal Cleavage b (010)

When fragments exhibiting the clinopinacoidal cleavage were immersed for a period of two-minutes in cold hydrofluoric acid they yielded figures which are *asymmetrical* in arrangement of planes. The etchings themselves can be turned into congruence if revolved about an axis normal to b (010), for 180°. See Plate 3, photograph 6, for a picture of a typical figure and Plate 2 for the general relations.

Summary

An etching study of orthoclase indicates:

(1) That there is one plane of symmetry containing the à and c̀ axes.

(2) That there is a center of symmetry.

(3) That the b crystallographic axis is a digonal axis of symmetry.

From these data it is seen that orthoclase belongs to the digonal equatorial type of the Monoclinic system.

Acknowledgment

The writer is indebted to Dr. A. P. Honess, Associate Professor of Mineralogy and Petrography at The Pennsylvania State College, for helpful suggestions relative to this study in crystal etching.

EXPLANATION TO PLATE III

Fig. 1. Orthoclase, c (001) cleavage overetched by HF.
Fig. 2. Orthoclase, c (001) cleavage etched with HF.
Fig. 3. Orthoclase, c (001) cleavage etched with HF.
Fig. 4. Orthoclase, c (001) cleavage etched with KOH. Note beaks.
Fig. 5. Orthoclase, c (001) cleavage etched with KOH.
Fig. 6. Orthoclase, b (010) cleavage etched with HF.
Fig. 7. Orthoclase, b (010) cleavage etched with HF. Low magnification

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Vol. 6	Quarterly	$1.00 per year
No. 1	February, 1931	Single numbers, 25 cents

ANNOUNCEMENTS

A SPECIAL Lecture, "On Safari," was delivered February 7 in the auditorium of the Institute by Dr. S. A. Barrett, Director of the Milwaukee Museum, to a large audience. Dr. Barrett brought out many interesting points of life in Africa when on safari. His lecture was well illustrated by motion pictures and slides.

The 1931 Westbrook Free Lectureship Course will be delivered Fridays and Saturdays, March 20, 21, 27, 28, in the auditorium by Dr. Aleš Hrdlička, Curator, Physical Anthropology, United States National Museum, on "The Problems of the Origin and Antiquity of the American Aborigines in the Light of Recent Explorations." An abstract of the syllabus appears on page 7. The full syllabus will be distributed at the lectures or may be obtained upon application.

The annual Announcement giving information as to all the educational activities of the Institute will be sent on request. Further inquiries should be made at the office, which is open from 9 A. M. to 5 P. M., on all business days.

Entered as second-class matter, September 10, 1926, at the Post Office, Philadelphia, Pa., under Act of August 24, 1912.

In Memoriam

HENRY LEFFMANN, 1847-1930

HENRY LEFFMANN, A.M., M.D., Ph.D., a Trustee of the Institute since 1903, died at his home Christmas Day, 1930. He began his association with the Institute as Lecturer in Botany in 1874. In 1875 he was transferred to the Department of Chemistry as lecturer and continued in that capacity until elected Professor of Chemistry in 1885. He continued in active teaching work until 1903, when he was elected Honorary Professor of Chemistry.

Dr. Leffmann was an excellent teacher and served as an inspiration to many students. He was thoroughly acquainted with every phase of the Institute's work, and to within a few months of his death he maintained an interest in many activities outside his chosen field of chemistry. Dr. Leffmann's service to the Institute, both as a member of the Faculty and as a Trustee, was marked by brilliance, punctual attendance at meetings and meticulous attention to detail.

A NEW TYPE OF INSECT HABITAT GROUP

John G. Hope
Wagner Free Institute of Science

Insects, though one of the most interesting of exhibits to the layman, have never had their share in the new trend of museum exhibition. In most institutions they are arranged in taxonomic order and stored away as research collections, available only to the student. A notable exception to this is the American Museum of Natural History, where some very beautiful and instructive groups have been installed. The average museum cannot spare the exhibition space and necessary funds for the construction of habitat groups illustrating insects; also, in large habitat groups the insects themselves take second place to the accessories and background in gaining and holding the interest of the observer.

With this in mind, we desired to devise a new type of habitat group for the illustration of small material, particularly insects. We wished to include a background, as this is a valuable aid in illustrating the exact nature of the habitat to be reproduced. For instance, it would be impossible to represent an orchard or a swamp with a small background alone, but with a painted background carefully blended in, it becomes a simple matter. To sum up the requirements suited to our needs:

1. A painted background.
2. No cabinet, eliminating the necessity of artificial lighting.
3. Economy of space.

A type of group that fulfills these requirements was made in the form of a plaque to hang in a wall case illuminated by electricity or daylight. There is no enclosing cabinet to cut off the light. The plaque was made of Academy Board, as this affords an excellent surface for the painting of the background. It is especially necessary in such a small group that the background be kept very soft so that it does not take precedence over the specimens themselves for holding interest. Its purpose is merely to *suggest* the type of habitat illustrated. We have found that the best way to keep the background subdued is to first give the portion upon which we are working a coat of white. While this is still wet we paint the section in, using a great deal of white on the palette when mixing the tints. By these methods there is no trouble at all in getting a soft, harmonious background. To finish it off, a one half-inch dull black border is run around the edge.

The next step is to support the specimens in some way upon this background. This matter is relatively simple—a spray of leaves, usually the food plant, solves the problem. In the case of a group illustrating the Seventeen-Year Cicada (*Cicada septendicem*) a part of a branch of a tree was cut to fit exactly in the space between the top and bottom borders of the background. Upon this the insects, some emerging from the pupal skins, and some of the empty skins were mounted. This was then fastened to the background by means of screws. The background represents a group of trees to carry out the effect given by the foreground. The amount of atmosphere produced by this simple arrangement is surprising.

Another group depicts the Monarch Butterfly (*Anosia plexippus*) at migration time. One butterfly was used, the numbers to show the flocking together being painted in the background. Without the use of a painted background it would be impossible to gain this effect except by using a much larger space. It is also possible by this means to show such valuable items as the time of year and the type of surrounding terrain, in this case low and marshy. The food plant, the milkweed, was used as a support for the specimen. The leaves were pressed from wax in the ordinary manner and a seed-pod was cast in wax. The plant, when assembled, was fastened directly to the background by means of glue and fine pins and the joint carefully waxed over. Parts of this same plant were carried into the background and some other milkweed plants were painted in as well. This serves to connect the specimen with the background, a point essential to the appearance of the finished product.

One group that varies somewhat from the others is the mount of the Mud-dauber Wasp (*Palopaeous cementarius*). In this case no painted background was used. Instead, the Academy Board was prepared to represent the wall of a farm building. A piece of wood representing the overhang of the eaves was glued to the board. Under this were placed the nests of the wasp and several specimens of the wasp. This group was particularly simple of construction, but it is almost bound to attract the attention of the museum visitor who would pass by a collection of pinned wasps without so much as giving them a second glance.

In the case of the Dragon Fly (*Anax junius*) we met with a peculiar condition. The background was painted with the lower part representing water. When the "fly" was mounted it appeared as though it were out over the water. A support for the insect proved a problem at first. Water plants did not seem suitable. Finally we hit upon the idea of using a bit of twig. This was arranged so as to appear to be projecting from the water with the dragon fly gently

poised thereon. This bit of twig was the complete foreground but it gave just the right effect. When it was in place the painted bank of the stream immediately receded, the water flattened out, and an illusion of distance remarkable for such a small group was obtained.

In this type of mount we were also able to add another touch which increased its educational value. This consisted of a small white card glued to the background in the lower corner. Upon this can be mounted various interesting and instructive objects which have a bearing on the group but which could not be used conveniently in any other way. This card is small enough not to attract undue attention from the main subject, yet it attracts enough attention to be instructive. For instance, in the Cicada group mentioned above the interesting biological fact that the males sing and the females do not is brought out. Two specimens, one a male and one a female, showing the presence of the sound apparatus in the one and the absence of such an organ in the other, were fastened to the card and attention drawn to this point by lettering beneath them. It is the opinion of the writer that specimens arranged and labeled this way in the main part of the group spoil its appearance. Two cicadas placed on their backs with labels calling attention to anatomical detail and so arranged on the trunk of tree used in this particular group would look anything but natural. However, when they are separated from the rest of the group and placed on such a card as the one mentioned above, they do not look a bit out of place. In this way the interesting emergence of the adult dragon fly from its pupal skin was also illustrated on that particular group. In the case of the wasps, some of the cells were opened to show the cocoon and along with this were shown the larva and pupa of the species. In the case of the Praying Mantis (*Tenoderma sinensis*) a very interesting thing can be illustrated in the peculiar construction of the nest. When making the nest, the female beats the liquid into a froth as it leaves her body. If a vertical section is made of one of the nests the central part is seen to be composed of larval cells. These are entirely surrounded by other, empty cells which have hardened out of the froth. These are for insulation and serve to protect the young over the cold winter months. Therefore, a vertical section was made of a nest and fastened, together with some of the young, on the card of the praying mantis group. This is an extremely interesting fact, but if the nest was merely put in a case with a label together with the insect, very few museum visitors would notice it.

Another point is the label. Someone has truly said that a good museum is a collection of labels generously illustrated with speci-

mens. On our labels we endeavor to give as many interesting details as possible. For these groups we use a label about the size of an ordinary library filing card and on it are given description of metamorphoses, peculiar feeding or mating habits, particulars as to habitat, etc.

Although the insects come first in adaptability to this type of construction, the small lizards, amphibians, and batrachians may also be successfully mounted in this manner. While the above mentioned groups are particularly adaptable to this manner of mounting, there seems to be no reason why birds and small mammals might not be used also. Undoubtedly, some modifications would be necessary to meet conditions which might arise, but probably some very nice effects could be obtained. The groups are very economical of space and we can put eighteen of them in a single wall case, 9 feet long by 7 feet high. They are hung by means of small brass rings fastened to the back of the Academy Board. These are slipped over hooks which are screwed into the back of the case. They could be lighted artificially by hidden lights in the top of the case, but in our case daylight seems to be sufficient.

The advantages of this type of group might be summed up as follows:

1. Possibility of having a painted background.
2 Elimination of an enclosing cabinet, thereby making artificial lighting unnecessary.
3. Economy of space.
4. Comparative low cost.
5. Possibility of illustrating interesting points in anatomy, etc.

The Richard B. Westbrook Free Lectureship, 1931

ABSTRACT OF SYLLABUS

of

FOUR LECTURES ON "THE PROBLEMS OF THE ORIGIN AND ANTIQUITY OF THE AMERICAN ABORIGINES IN THE LIGHT OF RECENT EXPLORATIONS"

BY ALEŠ HRDLIČKA, M.D., Sc.D.

Curator, Physical Anthropology, United States National Museum

FRIDAYS AND SATURDAYS, MARCH 20, 21, 27, 28, AT 8 P.M.

NO CARDS OF ADMISSION REQUIRED

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LECTURE 2.—Scientific Research up to 1926 and its Results. Studies of Thomas Jefferson, early government explorations and surveys: Schoolcraft, Smithsonian Institution, American Museum of Natural History, etc. Systematic researches on the Indian. Summary of research to date.

LECTURE 3.— Explorations in Alaska and Bering Sea, beginning to 1929. Early explorers of northwest. Russian explorations. Effects on the natives. Exploration of the Yukon with anthropometric, archeological and other work..

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Department of Geology and Paleontology

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BULLETIN

of the

WAGNER FREE INSTITUTE OF SCIENCE OF PHILADELPHIA

PUBLISHED BY THE INSTITUTE

Edited by the Publication Committee

WM. OTIS SAWTELLE
SAMUEL TOBIAS WAGNER, *Ex-officio*

Vol. 6	Quarterly	$1.00 per year
No. 2	May, 1931	Single numbers, 25 cents

ANNOUNCEMENTS

THE 1931 Westbrook Free Lectureship course on "The Problems of the Origin and Antiquity of the American Aborigines in the Light of Recent Explorations," by Dr. Aleš Hrdlička, Curator, Physical Anthropology, United States National Museum, delivered in the auditorium of the Institute March 20, 21, 27 and 28, was eminently successful both as to attendance and the brilliance of the lectures. A résumé of these lectures is contained in this number of the BULLETIN.

On April 17 a lecture was delivered under the Fannie Frank Leffmann Memorial Lectureship on "William Penn and the Indians," by Albert Cook Myers. Mr. Myers has devoted many years to historical research and is probably the foremost living authority on the history of William Penn. His lecture contained many new and interesting facts recently brought to light and many of his illustrations had never before been presented to the public.

The Institute is pleased to announce the publication of Volume 2 of its "Publications," a book of 436 pages, 50 plates and 204 text figures by Carroll Lane Fenton on "Evolution in the Genus Spirifer," $6 per copy. Orders for the book will be filled in the order of their receipt. The edition is limited to 750 copies.

This book is the result of eleven years' research on the Brachiopods of the Upper Devonian of Iowa, which entailed the careful examination and study of over ten thousand specimens.

In this work Dr. Fenton has advanced a theory of racial senescence based on metabolic changes undergone by these Devonian brachiopods, of which theory Dr. Rudolf Ruedemann, Paleontologist of the State of New York, who read the book in manuscript, says:

"His (Dr. Fenton's) interpretation of the changes observed, viz., as suggesting phyletic senescence through decreasing metabolism, is a novel one in the field of paleontology that cannot fail to be fruitful and lead to further investigation."

Because of its bearing on the Theory of Evolution the book should prove of interest to biologists as well as paleontologists.

The annual Announcement giving information as to all the educational activities of the Institute will be sent on request. Further inquiries should be made at the office, which is open from 9 A. M. to 5 P. M. on all business days.

A Synopsis of four Lectures on

THE PROBLEMS OF THE ORIGIN AND ANTIQUITY OF THE AMERICAN ABORIGINES IN THE LIGHT OF RECENT EXPLORATIONS

Delivered under the Richard B. Westbrook Free Lectureship, Wagner Free Institute of Science, March 20, 21, 27, 28, 1931

By ALEŠ HRDLIČKA, M.D., Sc.D.
Curator of Physical Anthropology in the United States National Museum, Smithsonian Institution

I

After Columbus, the other early explorers and the conquerors came in contact with the native population of the continents of America it was gradually realized that they had found a new kind of people. Mistakenly they called them Indians. There may have been anywhere from twenty-five to fifty millions of these natives, spread over both Americas and the adjacent islands. They were unevenly distributed, much the larger portion being on the western side of the continents. They formed a number of great cultural and political groups, having strong similarities of structure, language and customs within the group, but with considerable differences between the various groups. Yet, underlying these differences there was much basic unity.

All their languages were agglutinative, their grammatical structure, fundamentally at least, similar, the sounds used much alike and certain root words were widely distributed.

They all had clans based essentially on the maternal relation, and they generally married outside the tribe.

They believed in a future life, which however they visaged but indefinitely. They peopled even inanimate objects with spirits and with supernatural power. They never represented the most supreme

being by idols. They connected the heavenly bodies with their religion.

They were of very varied grades of social organization and of culture, at least two of the groups nearly reaching to a written language.

Some of them did no inconsiderable surgery, including trephining and even amputation. They were a promising people, who, but for outside interruptions, would probably have achieved high American development.

II

Some of the early speculators, not finding any direct reference to the race in the Scriptures, doubted whether the Indians were entirely human, which somewhat explains the early cruelties practised upon them. It needed the edict of a Pope to make men accept them as fellow beings. For other speculators they were "the lost tribes of Israel." America was the Ophir and Tarshish of the temple gold; they were Egyptians, as shown by their hieroglyphics and pyramids; while others believed them descended from the lost Atlantis or from the Phoenicians and Carthaginians.

After men ceased to hunt the explanation of their origin in the Bible, surmises began to approach more nearly to modern scientific theories. A few thought they had originated as a special creation in America. Some believed them to be Scythians or connected them with the Tartars. Their color showed them not to be Europeans or Africans, and their culture was unlike that of the Chinese or the Hindoos. So the Scythian and Tartar theories gained ground. The opinion then was advanced that they had crossed from Northern Asia into North America, and then had spread over the two Americas.

Thomas Jefferson believed them to be of Asiatic origin, and Benjamin Smith Barton, finding the west more thickly populated than the east, confirmed this idea, which gradually came to prevail.

III

The scientific study of the problem of the American Indian began in 1795, when the Secretary of War under the United States Government directed Leonard L. Shaw, a deputy agent to the Cherokees, to study the life, habits and language of the tribe, looking towards a preparation of an historical treatise on the Indians.

At the same time Johann Friedrich Blumenbach, in Germany, studying the diversities of man from a series of skulls, as well as from data on the living, divided Mankind into the White, Ethio-

pian, Yellow, Malay and Red races. This last name, applied to the American Indians, was a misnomer, for they are brown, the redness, where seen, being generally due to paint.

When, in 1840, President Jefferson sent Lewis and Clark on their memorable expedition to the far west, he directed them to study the Indians, giving attention not only to cultural features but also to physical characters, and intellectual and moral traits as well. This party brought back a considerable collection of clothing and utensils, together with a few skulls.

Many governmental surveys followed, and the leaders of each were directed to continue these studies. Thus a large collection of materials resulted.

The Boston Association of Phrenologists, in the early part of the nineteenth century, led a considerable stimulus towards the study of human skulls, and much attention was paid to the study of the crania of American Indians from this time on.

Dr. Samuel G. Morton, of the Academy of Natural Sciences, collected nearly a thousand crania, which were described in a large volume entitled "Crania Americana." His collection is still in the custody of the Academy of Natural Sciences, in Philadelphia.

This work was continued by Drs. Meigs and later Harrison Allen of Philadelphia, and more recently has been furthered by the collection of Mr. Clarence B. Moore, also of this city.

By this time men had come to recognize the essential unity of the Indians. They are all of varied shades of yellow-brown. All of them normally have straight, black hair (sometimes rusty from exposure to dry air and sun). The eyes of young Indians are often more or less oblique, though this generally disappears with age. They are unique in that eighty per cent of them have incisors which, on the lingual surface, are shovel shaped with a distinct rim. Their legs are usually lean, their hands and feet small. All this, and many other characteristics, point to a unity of racial origin.

It is quite possible, and even probable, that, a few at a time, other peoples may, in pre-Columbian time, have reached America in boats. The numbers in every such case, however, were too small to have left any physical traces. The so-called "white Indians" prove invariably to be albino.

Often finds of pre-Indian men are reported. Careful investigations have in every case proved them to be mistaken.

The Argentine finds, reported by Dr. Ammeghino to be Tertiary, and to show various transitionary forms, did not stand critical examination. Indian remains in no case point to a life on this continent older than some thousands of years. They are all post-glacial.

IV

By this time it became evident that studies must be made in Asia if it is desired to find the pre-Indian people. In 1912 the speaker made a trip to Siberia and Mongolia, in 1925 to Japan, Korea, China and the borders of Inner Mongolia, and five years later to India and Java. Thibet, closed for political reasons at that time, had to remain unvisited, but the people of the northern border were examined.

These researches disclosed the fact that some thousands of years ago there lived in Asia a yellow-brown people, of whom, to this day, many small and widely scattered groups may be found. Mongolian male hair dress is much like that of the Indians, and would facilitate scalping. There are striking similarities between Igorots and Indians. The inhabitants of Thibet show typical Indian characteristics, and so do those of Formosa.

If the Indians came from Asia, the obvious path was across the Bering Strait and along the Seward Peninsula, which juts out from Alaska, and is separated from Asia only by the narrow strait.

In 1926 Dr. Hrdlička undertook an extensive survey in Alaska, descending the Yukon to Norton Sound, passing up the coasts to Point Barrow and then down again to the Aleutian Islands. The results showed there was no difficulty of man reaching America from northeastermost Asia in boats and there was no need of any land connection.

Eskimos are found along parts of the Siberian coast. They cross both ways between Asia and America, and make prolonged journeys over the Bering Sea, often in boats packed with people. This was evidently the earlier method, as it is far easier than travel over the tundras.

No remains of great age were so far found in Alaska because digging in frozen ground beyond a depth of two feet is practically impossible, and because everything along the coasts and rivers there has changed greatly in the course of the time.

Earlier village sites are numerous and larger than those of to-day, showing a population denser than at present. The Eskimos are derived from the same old stock as the Indians but are a later development. If the spread human hand be used to represent the American Aborigines, then the diverging fingers stand for the different Indian types, the somewhat more aberrant thumb shows the Eskimo, while the palm, common to both the fingers and the thumb, represents the old Asiatic mother stock of both.

Very many new data and objects were brought from this trip, including a thus far unknown fossilized ivory culture found on St.

Lawrence Island and about the Bering Strait. A number of the fossil ivory knives, marked on the handle with sitting animals, are similar to some found in Mexico, while other objects, but slightly altered, occur as far as Panama and Siberia.

It is quite clear that a people of considerable culture passed from Asia to America in boats. The severer climate of Siberia would of itself offer a sufficient motive for the journey. Because of the conditions in Alaska, we may scarcely hope to find traces of the earlier migrations, which doubtless occurred, not in mass, but in many smaller groups. These movements lasted over a long time, and brought to America not only distinct sub-types of the old race, but also different languages and even more or less differing culture. These migrations bent south to Bristol Bay, whence six or seven passes opened to them the way by which they might reach the Gulf, the northwest coast and thence spread over the two continents.

These lectures were illustrated by many excellent lantern slides, largely original, showing buildings, the people and cultures.

The foregoing résumé of these lectures was written by Dr. S. C. Schmucker and edited by Dr. Hrdlička.

PUBLICATIONS OF THE INSTITUTE

TRANSACTIONS

Vol. 1.—Explorations on the West Coast of Florida and in the Okeechobee Wilderness. *Angelo Heilprin.* $2.50

Vol. 2.—Report on Fresh-water Sponges Collected in Florida. *Edward Potts.*
Notice of Some Fossil Human Bones. *Joseph Leidy.*
Description of Mammalian Remains from Rock Crevice in Florida. *Joseph Leidy.*
Description of Vertebrate Remains from Peace Creek, Florida. *Joseph Leidy.*
Notice of Some Mammalian Remains from Salt Mine of Petite Anse, Louisiana. *Joseph Leidy.*
On Platygonus, an Extinct Genus Allied to the Peccaries. *Joseph Leidy.*
Remarks on the Nature of Organic Species. *Joseph Leidy.* $1.00

Vol. 3.—Parts 1, 2, 3, 4, 5, 6.—Contributions to the Tertiary Fauna of Florida. *William H. Dall.* $15.75

Vol. 4.—Fossil Vertebrates from the Alachua Clays, Florida. *Joseph Leidy.* $1.25

Vol. 5.—Study of Hawaiian Skulls. *Harrison Allen.*
Notes on the Palæontological Publications of Prof. William Wagner. *William H. Dall.* $1.00

Vol. 6.—Selenodont Artiodactyls of the Uinta Eocene. *William B. Scott.* $1.00

Vol. 7.—Contributions to the Mineralogy of the Newark Group in Pennsylvania. *Edgar T. Wherry.*
A Comparative Study of the Radio-Active Minerals in the Collection of the Wagner Free Institute of Science. *Carl Boyer and Edgar T. Wherry.* $0.50
Vegetation of South Florida. *John W. Harshberger.* $2.50
Studies in Carbohydrates. *Charles H. LaWall and Sara S. Graves.* $0.50

Vol. 8.—Special Lectures by the Teaching Staff of the Institute. $2.00

Vol. 9.—Part 1.—The Vegetation of the Hackensack Marsh: A Typical American Fen. *John W. Harshberger and Vincent G. Burns.* $1.00
Part 2.—On the Life History of an Economic Cuttlefish of Japan; Ommastrophes sloani pacificus. *Madoka Sasaki.* $1.00

Vol. 10.—Contributions by the Faculty of the Institute. Post-fixation Development. *H. Leffmann.* Reconstruction of Columbia Bridge. *S. T. Wagner.* Origin and Relationship of North American Song Birds. *S. Trotter.* The Three-Electrode Bulb in Radio Signals. *L. B. Seely.* Detection of Methanol in Presence of Ethanol. *C. H. LaWall.* Chemical Attraction. *D. W. Horn.* $2.00

Vol. 11.—Biochemistry of American Pitcher Plants. *Joseph S. Hepburn, Elisabeth Q. St. John and Frank M. Jones.* $2.50

PUBLICATIONS

Vol. 1.—A Revision of the Ostracod Genus *Kirkbya* and Subgenus *Amphissites.* *Robert Roth.* $1.00

Vol. 2.—Studies of Evolution in the Genus Spirifer. *Carroll Lane Fenton.* $6.00

BULLETIN

Bulletin of the Institute. Quarterly — $1.00 per year
Single numbers, 25 cents.

Republication of Conrad's Fossils of the Medial Tertiary of the United States. Introduction by *William H. Dall.* (Out of Print.)

WAGNER FREE INSTITUTE OF SCIENCE

Montgomery Ave. and Seventeenth St., Philadelphia, Pa., U. S. A.

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BULLETIN

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WAGNER FREE INSTITUTE OF SCIENCE

OF

PHILADELPHIA

VOLUME VI, NO. 3, AUGUST, 1931

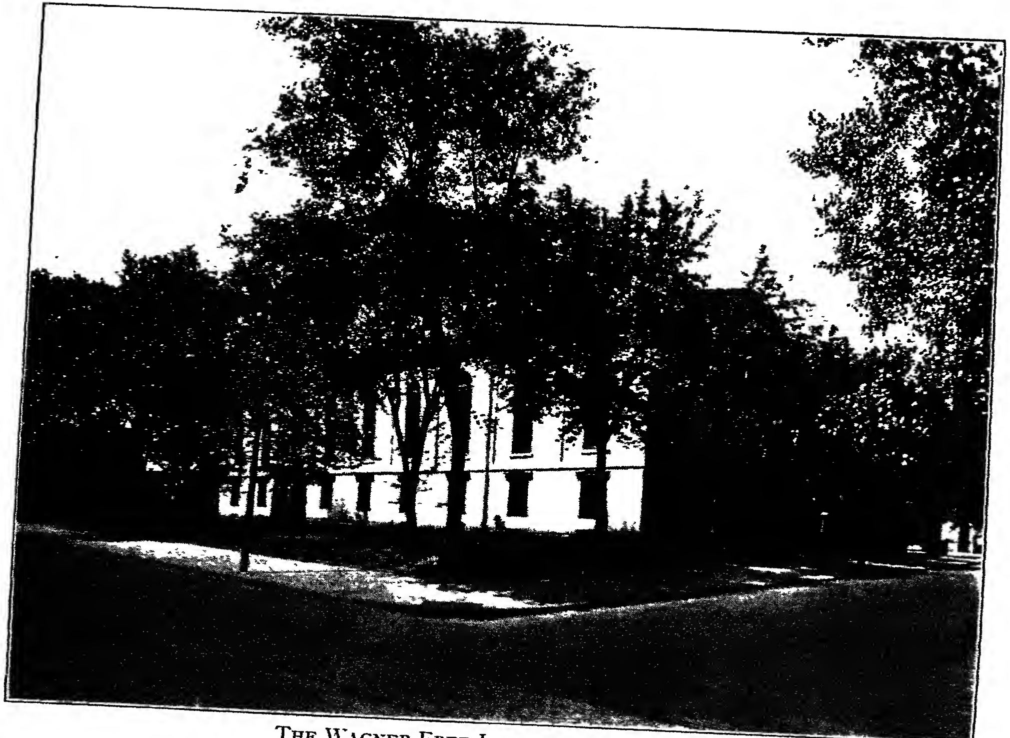
ANNOUNCEMENT

FOR

SESSION OF 1931-32

EIGHTY-FOURTH YEAR

WAGNER FREE INSTITUTE OF SCIENCE OF PHILADELPHIA
SEVENTEENTH STREET AND MONTGOMERY AVENUE
PHILADELPHIA, PA., U. S. A



The Wagner Free Institute of Science
Montgomery Ave. and Seventeenth St.

BULLETIN

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WM. OTIS SAWTELL, *Editor*

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Department of Geology and Paleontology

Benjamin F. Howell, A.M., Ph.D.

Carl Boyer, *Director*

*Deceased.

In Memoriam

SAMUEL TOBIAS WAGNER

AUGUST 30, 1861—AUGUST 7, 1931

Samuel Tobias Wagner was educated in civil engineering, graduating with the degree of B.Sc. from the University of Pennsylvania in 1881 with distinguished honors. He was awarded the degree of C.E. from the same institution in 1884. After graduation he served as draftsman, inspector, assistant master mechanic and superintendent of shops of the Phoenix Iron Company from 1881 to 1893.

In 1893 he was made assistant engineer in charge of the Pennsylvania Avenue Subway and Tunnel, Bureau of Surveys, Philadelphia. From 1900 to 1902 he was assistant engineer in charge of improvement and filtration of water supply in Philadelphia. From 1902 to 1915 he was assistant engineer in charge of abolishment of grade crossings, Philadelphia and Reading Railway. In 1915 he was appointed chief engineer of the Reading System, which position he occupied until, retiring from active service in 1927, he was retained in the capacity of consulting engineer by the railroad.

In 1892 he was elected Professor of Engineering at the Wagner Free Institute of Science, in which capacity he served until 1926.

He was elected a Trustee of the Institute April 3, 1894, and President of the Board of Trustees in 1921. He also served for many years as chairman of the Committee on Instruction and as President of the Faculty.

Professor Wagner's sunny disposition and sterling qualities endeared him to all. He thought of the problems of the Institute in the terms of engineering, and his technical knowledge, combined with sound common sense, were a bulwark of strength to his associates and to the staff which worked under him.

He was an excellent teacher, who gave much of himself because his heart was in his work, and he was always deeply interested in the Institute and its workings, with which he had so much to do. Professor Wagner was a man of broad culture, deeply interested in the affairs of church, state and nation as well as those of his chosen field of engineering and of educational activity.

His active career was seldom marred by illness, and he continued sturdy and steadfast to the end, when an unfortunate accident terminated a life which served others more than himself.

W. O. S.

HISTORICAL NOTE

The Wagner Free Institute of Science owes its establishment to the liberality and public spirit of William Wagner and his wife, Louisa Binney Wagner. In his early life Professor Wagner made extensive voyages in the service of Stephen Girard, and had opportunities to visit scientific institutions and make the acquaintance of scientific workers. He soon developed a strong interest in the natural sciences, especially geology and mineralogy, and devoted a large part of his life to studying these topics and collecting material to illustrate the teaching of them.

In 1847 he began to give free lectures at his home, near the present location of the Institute building, at that time in the rural section of the county. In 1855 the Institute was incorporated by the Legislature, a faculty was appointed and lectures were given at Commissioners' Hall, Thirteenth and Spring Garden Streets, by permission of the city authorities. In a few years the city was obliged, by its own needs, to withdraw the privilege of the hall, and Professor Wagner arranged to erect a suitable building on his own property. This was completed in May, 1865, and lectures at once given in it. In 1864 a deed of trust was executed by Professor Wagner and his wife, furnishing a permanent endowment of the Institute.

In 1885, by the death of the founder, the care of the Institute passed into the hands of a Board of Trustees, since which time many improvements have been made in the building, and extensive additions to the equipment in the museum and library and in scientific apparatus. In 1901 a wing was built for the use of a branch of the Free Library of Philadelphia.

FACILITIES FOR INSTRUCTION

Lectures and Class-Work

Instruction at the Wagner Free Institute of Science is conducted by means of public lectures, supplemented by class-work, and is without charge and without restriction of race or sex. The class-instruction is given partly at the close of each lecture, partly by written exercises. The Museum and Reference Library of the Institute are available for aid in the instruction work and are freely used. In addition, the Wagner Institute Branch of the Free Library of Philadelphia affords abundant opportunities for collateral reading.

At the close of each course of lectures an examination is held, to which those who have attended the classes are admitted, and on passing such examination the pupil is awarded a certificate. Certificates are awarded at a public meeting held in May of each year.

The lecture courses are arranged to cover a given topic in four

successive years, and to those who hold certificates for each of these courses a full-term certificate is issued.

MUSEUM

The Museum covers the whole field of natural science and contains illustrations in all departments of biology, geology, mineralogy, metallurgy, and engineering. The specimens are arranged so as to be easily studied and are open to inspection from 2 to 5 o'clock Wednesday and Saturday afternoons, except legal holidays.

Teachers with classes and others desiring to use the museum for special studies can, by applying at the office, gain admission any week-day, except holidays, as above stated, between the hours of 9 A. M. and 5 P. M.

The collections of the museum have been used for a number of years for instruction by means of "Museum Talks," as noted below, and by arrangement with work at Temple University and the Division of Science Teaching of the Board of Public Education those teaching General Science in the eighth and ninth grades of the Philadelphia public schools or preparing for such teaching may secure elective credits upon the completion of the work as follows:

General Science II

Monday,	7 P. M. to 8 P. M.	Museum Lecture.
	8 P. M. to 9 P. M.	Lecture Course—Botany and Zoology.

NOTE: Four semester hours of credit will be given for the complete Monday evening program.

Tuesday,	8 P. M. to 9 P. M.	Lecture Course—Inorganic Chemistry and Geology.
Wednesday,	8 P. M. to 9 P. M.	Lecture Course—Organic Chemistry and Physics.

NOTE: An additional two semester hours of credit per evening may be obtained by electing Tuesday or Wednesday evening.

Monday evening is a prerequisite for these, however.

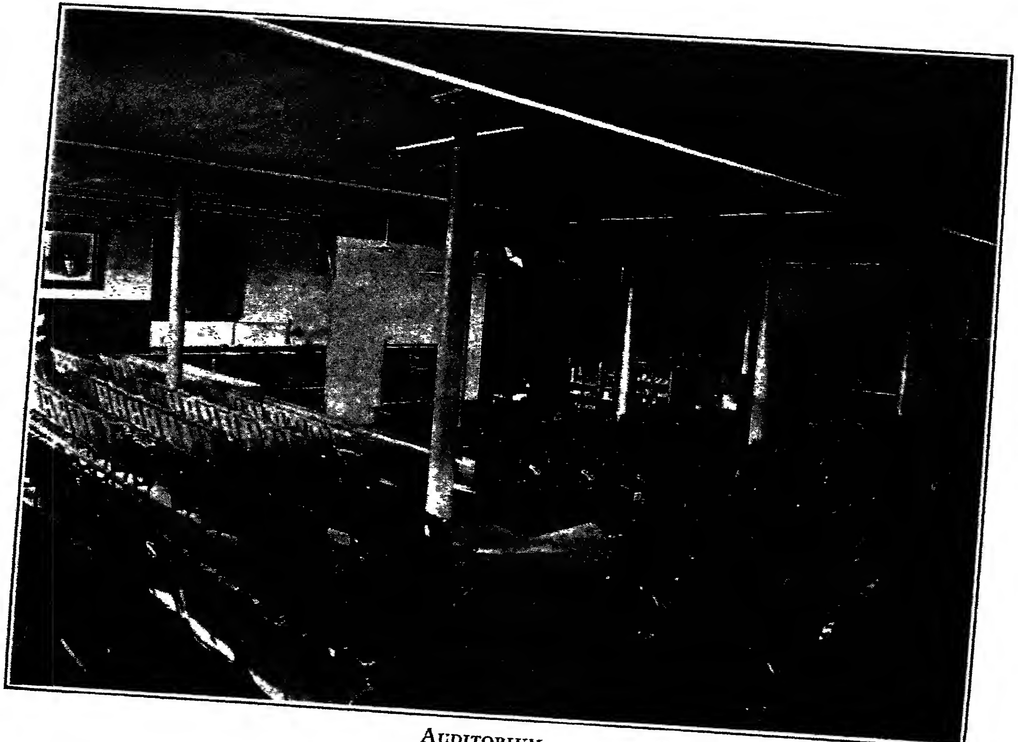
Further information concerning these courses may be obtained at the Office of the Institute.

LIBRARIES

The Reference Library contains text-books and works of reference in all departments of science, encyclopedias, many works devoted to literature, and an assortment of dictionaries of English, classical and foreign languages. It is open on all regular business days from 9 A. M. to 9 P. M., a librarian being in attendance to assist students.

The Circulating Library is a branch of the Free Library of Phila-

Museum



Auditorium

delphia. It is open every business day from 9 A. M. to 9 P. M. Books may be taken out under the usual rules of the Free Library. Many periodicals—American and foreign, scientific and literary—are on file.

BULLETIN

The BULLETIN of the Institute is quarterly. It contains information as to the methods of work of the Institute, announcements of additions to its collections and original contributions to science. The sixth volume is now in course of publication. The subscription price is $1.00 per year, single copies, 25 cents.

SPECIAL LECTURES

By the liberality of Richard Brodhead Westbrook, D.D., for many years a trustee of the Institute, and of his wife, Henrietta Payne Westbrook, provision has been made for lectures independent of the general courses of the Institute and covering a wide range of topics. A list of lectures so far given and of publications thereof so far as issued is printed on second page of cover

Announcement of the course for 1932 will be made in a subsequent issue of the BULLETIN.

The income of a fund given by Dr. Henry Leffmann is applied to providing special lectures as the Fannie Frank Leffmann Memorial Lectureship.

The *Philadelphia Natural History Society* meets on the third Thursday of each month, except June, July and August. These meetings are open to all persons interested in the subjects.

RESEARCH

The Institute has carried on research work since 1885, most of the results having been published in its Transactions and Publications. A list of these will be found on the fourth cover page. Results of research appear also from time to time in the BULLETIN.

The Henry Leffmann Chemistry Research Fund has been established for perpetual service.

CLOSING EXERCISES

In May of each year the courses of instruction are formally closed by a public meeting at which addresses are given and the certificates awarded.

At the closing exercises in May, 1931, after an address by Professor Samuel C. Schmucker, Dean of the Faculty, and awarding of certificates, Dr. Laurence M. Gould, Second in Command of the Byrd Antarctic Expedition, delivered a lecture entitled, "With Byrd to the Bottom of the World."

FULL TERM CERTIFICATES AWARDED

ENGINEERING

Robert B. Bowman
Paul W. E. Gehris
Chauncey R. Kay

BOTANY

Florence McIlravey
Henry C. Savage

ZOOLOGY

Henry C. Savage

PHYSICS

H. L. Grabosky

GEOLOGY

Dr. L. D. Frescoln
William D. S. Gillette
Mrs. Katharine R. Guest
Henry C. Savage

1930–1931 CERTIFICATES AWARDED

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Walter J. Callahan
Alfred W. Fischer
Paul W. E. Gehris
William D. S. Gillette
Chauncey R. Kay
Peter G. Kolupaev
John J. Kyle

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Newton Gillette
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Emanuel Hocking
Harry A. Lloyd
Florence McIlravey
Clifton V. Mimms
Mrs. Reba A. G. Mimms
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Henry L. Singer
Ida R. Strohlein
Charlotte L. Temple
Mrs. W. E. Toner
William K. Williams

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H. L. Grabosky
John G. Hope
Seymour S. Kety
Joseph J. Kolb
William K. Williams

ORGANIC CHEMISTRY 2

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John S. Cooper
John Glenn
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J. Oakley Hendry
Frank P. Ingenito
Susan Kazimer
Emma F. Keeley
Joseph J. Kolb
Mrs. Dorothy G. Lloyd
Harriett Lockard
Viola M. McNaughton
Mary E. Mathis
Mrs. Reba A. G. Mimms
Edith M. Porter
Harry Schecter
Louis B. Seiden
Charlotte L. Temple
J. Tichner
Norman W. Trew
Lena M. Torrisi
William K. Williams

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Emanuel Hocking
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Frank P. Ingenito
Ruth Kennedy
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Mrs. Maud Schearer
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Henry L. Singer
Fred Stokes
Ida R. Strohlein
Charlotte L. Temple
William K. Williams
Dr. Henry Winsor

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Harry W. Fisher
Dr. L. D. Frescoln
William D. S. Gillette
Mrs. Katharine R. Guest
William Heck
John G. Hope
Clifton V. Mimms
Mrs. Reba A. G. Mimms
Henry C. Savage
Ellis E. Stineman
Fred Stokes
Charlotte L. Temple
Lena M. Torrisi
Dr. Henry Winsor

PHYSICS 1

H. L. Grabosky
Joseph J. Kolb
Charlotte L. Temple
Norman W. Trew
William K. Williams
Dr. Henry Winsor

FACULTY

SAMUEL CHRISTIAN SCHMUCKER

A.M., M.S., Sc.D., Muhlenberg College.
Ph.D., University of Pennsylvania.
For thirty years Professor of Biological Sciences, State Teachers College, West Chester, Pa.
For twenty years head of Science Department, Summer Schools, Chautauqua, N. Y.
For fifteen years Lecturer on Biology, Brooklyn Institute of Arts and Sciences.
Professor of Botany, Wagner Free Institute of Science, 1908–1926.
Professor of Zoology, Wagner Free Institute of Science, 1926 to date.
Dean of the Faculty.
Author of

"The Study of Nature." (Lippincott Co.)
"The Meaning of Evolution."
"Man's Life on Earth."
"Heredity and Parenthood." (Macmillan Co.)

JOHN WAGNER, JR.

B.S. in C.E. 1913, University of Pennsylvania.
C.E. 1920, University of Pennsylvania.
Assoc. M., Am. Soc. C. E.
1913–1916, Draftsman, Phoenix Bridge Company.
1916–1921, Office of Engineering Bridges and Buildings, Pennsylvania Railroad, including two years' service with the Army as First Lieut. and Captain in the Cavalry.
1921–1926, Assistant Supervisor Track, Reading Company.
1926–1928, Supervisor Track, Reading Company.
1928 to date, Industrial Agent, Reading Company.
Professor of Engineering, Wagner Free Institute of Science, 1926 to date.

LESLIE BIRCHARD SEELY

Graduate, State Normal School, Bloomsburg, Pa.
Taught school, Luzerne and Snyder Counties, Pa.
Assistant instructor in physics and chemistry, Bloomsburg, 1899–1902.
Graduate, Haverford College, 1905.
Head Master, Friends Institute, Chappaqua, N. Y., 1905.
Instructor in physics, Northeast High School, Philadelphia, 1906–1915.
Head of Science Department, Germantown High School, 1915–1923.
Principal, Roxborough High School, 1923–1924.
Principal, Germantown High School, 1924 to date.
Graduate courses, University of Pennsylvania and Brooklyn Institute, 1906–1910.
Honorary degree of Doctor of Pedagogy, Ursinus College, 1926.
Professor of Physics, Wagner Free Institute of Science, 1912 to date.
Publications:

"Description of Two New Distomes," Biological Bulletin, Lancaster, Pa., 1906.
"Ether Waves and the Messages They Bring."
"The Physics of the Three-electrode Bulb," Transactions of the Wagner Free Institute of Science.

DAVID WILBUR HORN

A.B., Dickinson College, 1897.
A.M., Dickinson College, 1898.
Ph.D., Johns Hopkins University, 1900.
Assistant in Chemistry, Johns Hopkins University, 1900–1901.
Associate and Associate Professor of Chemistry, Bryn Mawr College, 1901–1907.

Lecturer in Hygiene, Hahnemann Medical College, 1911 to date.
Head of Pre-Medical School of Science, Hahnemann Medical College, 1916–1921.
Professor of Physics and Physical Chemistry, Philadelphia College of Pharmacy and Science, 1921 to date.
Professor of Inorganic and Physical Chemistry, Wagner Free Institute of Science, 1911 to date.
Chairman of Philadelphia Section of American Chemical Society, 1904 and 1905.
Fellow of American Association for the Advancement of Science.
Fellow of the Royal Society of Arts of London.

IVOR GRIFFITH

Early education at the Bethesda Academy, Wales, and came to America in 1907.
P.D., Philadelphia College of Pharmacy and Science, 1912.
Ph.M., Philadelphia College of Pharmacy and Science, 1921.
Director of Research, John B. Stetson Company.
Director of Laboratories, Stetson Hospital.
Editor, American Journal of Pharmacy.
Assistant Professor of Pharmacy, Philadelphia College of Pharmacy and Science.
Professor of Organic Chemistry, Wagner Free Institute of Science, 1926 to date.
Secretary of the Faculty of Wagner Free Institute of Science.
Publications:
"Recent Remedies," 1926 (revised 1928).
"Popular Science Lectures" (Editor) (eight volumes).
U. S. Dispensatory (Collab. Editor).
Formula Book, A. Ph. A. (Editor).
Contributor to current chemical, pharmaceutical and medical literature.

GEORGE BRINGHURST KAISER

Educated in private schools.
Graduate, Franklin School.
After graduation spent several years in intensive botanical study and field work in northeastern United States.
Secretary of the Botanical Society of Pennsylvania for seven years and leader of its field trips; at present is First Vice-President of the Society.
Instructor in Botany, School of Horticulture for Women.
Professor of Botany, Wagner Free Institute of Science, 1927 to date.
Curator, Moss Herbarium, Sullivant Moss Society.
Treasurer, Delaware Valley Naturalists' Union.
Member, Academy of Natural Sciences.

BENJAMIN FRANKLIN HOWELL

B.S., A.M., Ph.D., Princeton University.
Associate Professor of Geology and Paleontology, Princeton University.
Professor of Geology and Paleontology, Wagner Free Institute of Science, 1927 to date.
Curator of Invertebrate Paleontology in Princeton University.
Fellow of the Paleontological Society.
Secretary of the Paleontological Society.
Fellow of the Geological Society of America.
Fellow of the American Association for the Advancement of Science.
Associate Member of the Paleontological and Mineralogical Division of the American Association of Petroleum Geologists.
Member of the Sub-committee on Micropaleontology of the National Research Council.
Editor of the section of General Paleozoology of *Biological Abstracts*.
Specializes in Cambrian Paleontology and Geology.
Associated with U. S. Geological Survey, the U. S. National Museum, Geological Survey of Canada, Canadian National Museum, Geological Survey of Vermont, Geological Survey of Montana, as a consulting paleontologist and research associate.

REGULAR LECTURES, SESSION OF 1931–1932

BOTANY 1

PROFESSOR KAISER

Morphology

Lectures begin at 8 P. M.

1. Monday, September 14.
   Seed and Seedling. Historical outline of botany and branches of the science. Morphology and metamorphosis defined. Parts of the seed. Embryo, cotyledons, endosperm. Growth of seedling.
2. Monday, September 21.
   Root. Composition and functions. Duration: annual, biennial, perennial. Tap, fibrous, adventitious, aerial and prop roots. Poison ivy, orchid, banyan and screw pine.
3. Monday, September 28.
   Stem and Bud. Subterranean and aerial stems. Rhizome, tuber, stolon, runner, scape, thorn and tendril. The tree trunk. Naked, scaly, sub-petiolar buds. The bulb.
4. Monday, October 5.
   Leaf. Its parts and uses. Simple and compound, pinate and palmate leaves. General form, apex and margin. Equitant, connate and perfoliate leaves. Special functions as pitchers, insect traps, buoys, etc.

No lecture October 12.

5. Monday, October 19.
   Flower. Receptacle. Calyx. Corolla. Stamens. Pistils. Ovary. Regular and irregular flowers and their modifications. Perfect and unisexual flowers. Monoecism and dioecism.
6. Monday, October 26.
   Phyllotaxy and Anthotaxy. Vernation and aestivation. Arrangement of leaves and flowers on the stem and in the bud. Cyclical and spiral phyllotaxy. Racemose and cymose inflorescence.
7. Monday, November 2.
   Fruit. Dehiscent and indehiscent dry fruits. Fleshy fruits: simple, aggregate and collective or multiple. Simple and compound types. Derivation and development.
8. Monday, November 9.
   Pollination and Fertilization. Alighting of pollen grains on stigma and growth of the pollen tube. Double fertilization of egg cell and endosperm nucleus. Microspore and macrospore or megaspore.
9. Monday, November 16.
   Cell. Its form: spherical, cylindrical, cubical or hexagonal. Naked protoplasm. Embryonic cell and its contents. Cytoplasm, nucleus and chromatophores and their derivatives.
10. Monday, November 23.
   Mitosis. Indirect nuclear division. Chromosomes: bearers of heredity. Phases of vegetative mitosis. The formation of pollen grains and egg cells known as the Reduction Division and its characteristics.

11. Monday, November 30.
Differentiations of the Cell. How the cell wall is built up. Its constituents: cellulose, pectin, chitin. Division of labor. Single cells and vessels. Kinds of cells and how their walls change. Intercellular spaces.

12. Monday, December 7.
Contents of the Cell. The manifold inclusions of the cytoplasm. Mineral salts and organic acids. Alkaloids. Glucosides. Bitter principles. Peptonizing ferments. Calcium oxalate and aleurone grains. Inclusions of the chromatophores.

13. Monday, December 14.
Tissues. Meristems: actively dividing tissues. Permanent tissues. Epidermal system. Stomatal apparatus. Mechanical tissue system. Conducting tissues. Secretory tissues. Latex.

14. Monday, December 21.
Aerial Stem. Mono- and di-cotyledons. Xylem and phloem. Medulla. Medullary rays. Cambium and cork cambium or phellogen. Sap and heart-wood: alburnum and duramen. Recapitulation.

INORGANIC CHEMISTRY 3

PROFESSOR HORN

Descriptive Chemistry

Lectures begin at 7.45 P. M.*

1. Tuesday, September 15.
Carbon. Sources, properties. Lampblack, graphite. Diamonds, real and artificial. Coal, petroleum, asphaltum, natural gas. Hydrocarbons, acetylene. Carbon tetrachloride. Carbides.

2. Tuesday, September 22.
Carbon (Continued). Carbon monoxide; water gas, producer gas. Carbon dioxide, carbonates, bicarbonates. Carbon disulphide.

3. Tuesday, September 29.
Inorganic Compounds of Carbon and Nitrogen. Cyanides, ferrocyanides, ferricyanides, nitroprussides. Cyanates, sulphocyanates. Cyanamide. Chemistry of blue-printing.

4. Tuesday, October 6.
Silicon. Occurrence, preparation, properties. Silicic acids. Colloidal silicic acid. Silicates; glass, pottery, water glass. Silicon tetrafluoride. Fused quartz.

5. Tuesday, October 13.
Significance of the term "Metal." Historical. Electromotive series. Noble and base metals. Metallic properties. Metallurgy. Metallography. Alloys. Amalgams.

6. Tuesday, October 20.
Sodium. Salt, nitre, and borax. Leblanc and Solvay Processes. Sodium bicarbonate, carbonate, hydroxide, metal, oxide and peroxide. Baking powders, chemical fire-extinguishers.

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* Please note the hour.

7. Tuesday, October 27.
   Potassium, Rubidium, Caesium. Potash. Causticizing potash. The Stassfurt deposits, other sources of potassium salts. Saltpetre. Fixed alkalis. Hydrolysis. Spectrum analysis.
8. Tuesday, November 3.
   Lithium, Barium, Strontium. The metal lithium. Lithia waters. Barytes, precipitated barium sulphate. Lithopone. Barium oxides. Strontium salts. Fire-works.
9. Tuesday, November 10.
   Calcium. Limestone, other natural carbonates of calcium. Hardness in water. Limestone caverns. Gypsum, plaster of Paris. Mortar, cement. Bones, phosphate rock, fertilizers.
10. Tuesday, November 17.
   Magnesium and Zinc. Sources, preparation, properties. Magnesite, dolomites. Magnesium salts. Metallic magnesium and zinc. Industrial uses of the metals. Zinc white.
11. Tuesday, November 24.
   Aluminum. Occurrence, preparation, properties. The alums. Uses of metallic aluminum. Clay. Emery. Gems. The Goldschmidt Process, thermite. Lakes.
12. Tuesday, December 1.
   Manganese and Chromium. Occurrence, preparation. Multi-valence. Manganese salts, permanganates. Manganese alloys. Chromium salts, chromates, and poly-chromates. Nichrome. Rustless steels.
13. Tuesday, December 8.
   The Analytical Scheme of the Metals. The subdivision of the metallic ions into groups. Group separations. Sub-group separations. Confirmatory tests. Handling "Unknowns."
14. Tuesday, December 15.
   Metal-Ammonia Compounds. Some complex ammonia compounds of mercury, copper, cobalt, nickel, platinum and chromium. Werner's Hypothesis. Stereo-isomerism in inorganic compounds.

ORGANIC CHEMISTRY 3

PROFESSOR GRIFFITH

Cyclic Hydrocarbons

Lectures begin at 8 P. M.

1. Wednesday, September 16.
   Destructive Distillation. Fractional Distillation. Coal tar (the ugly duckling of organic chemistry), wood tar; their industrial production and general uses.
2. Wednesday, September 23.
   The Genealogic Table of Old King "Coal." Fractionating coal tar. Commercial products—light oil, dead oil, heavy oil, anthracene oil.
3. Wednesday, September 30.
   Benzene and its Homologues. Kekulé and his ring. Theories of molecular structure of cyclic hydrocarbons.

4. Wednesday, October 7.
   Derivatives of Benzene. Aromatic aldehydes. Alcohols, esters.
5. Wednesday, October 14.
   Derivatives of Benzene (Continued). Aromatic acids, benzoic, salicylic, etc.
6. Wednesday, October 21.
   Derivatives of Benzene (Concluded). Phenols: Phenol, cresol, resorcinol, pyrogallol.
7. Wednesday, October 28.
   Synthetic Medicines from Coal Tar. The fever chasers: Acetanilid, phenacetin, antipyrin.
8. Wednesday, November 4.
   Synthetic Medicines from Coal Tar (Concluded). The sleep coaxers and germ killers: Barbital-sulphonal. Hexyl-resorcinol. Arsphenamine. Chloramine.
9. Wednesday, November 11.
   The Nitrogen Branch of the Coal Tar Family. Anilin—its homologues and derivatives, pyridin and quinolin. Nitrobenzene.
10. Wednesday, November 18.
    The Rainbow in a Barrel. Dyes from coal tar. Perkins and his epoch-making mistake. Classification and general uses.
11. Wednesday, November 25.
    Dyes from Coal Tar (Continued). Color and chemical constitution. Coal tar dyes in the textile industries. The new American dyestuffs industry.
12. Wednesday, December 2.
    Dyes from Coal Tar (Continued). The theory of dyeing. The practice of dyeing.
13. Wednesday, December 9.
    Dyes from Coal Tar (Continued). Dyes as indicators and laboratory stains. Dyes as medicinal agents. Dyes in the paint and lacquer industry.
14. Wednesday, December 16.
    Dyes from Coal Tar (Concluded). Uses in food-stuffs. Certified dyes. Detection and distinction from natural colors.

ENGINEERING 1

PROFESSOR WAGNER

Materials of Engineering Construction

Lectures begin at 8 P. M.

1. Friday, September 18.
   Properties of Engineering Materials. Force. Stresses. Properties. Testing machines.
2. Friday, September 25.
   Stone. Classification. Composition. Physical properties. Unit stresses.
3. Friday, October 2.
   Brick. Composition. Manufacture. Physical properties. Special uses.
4. Friday, October 9.
   Lime and Cements. Composition and manufacture of lime and its uses. Classification. Manufacture. Physical properties. Tests and uses of cements.

5. Friday, October 16.
Mortar and Concrete. Sand. Lime mortar. Cement mortar. Grout. Strength. Uses.
6. Friday, October 23.
Concrete and Mastics. Concrete: proportions, mixing, consistency, placing, surface finish. Reinforced concrete: strength, uses. Mastics: composition, occurrence in nature, uses.
7. Friday, October 30.
Wood. The tree. Composition. Cell structure. Classification. Preparation for the market.
8. Friday, November 6.
Wood (Concluded). Seasoning, shrinkage. Durability. Enemies of wood. Preservation processes. Physical properties and unit stresses.
9. Friday, November 13.
Cast Iron. Ores of iron. Occurrence in nature. Construction of the blast furnace. Metallurgy of the blast furnace. Physical properties and uses.
10. Friday, November 20.
Wrought Iron. Chemical and physical composition. The puddle furnace. Physical properties. Unit stresses.
11. Friday, November 27.
Steel. Definition. Alloys with carbon, nickel and chromium. Processes of manufacture. Recarbonization of wrought iron.
12. Friday, December 4.
Steel (Continued). Gas producers and their construction. Open hearth process.
13. Friday, December 11.
Steel (Concluded). Bessemer process and its limitations. Physical properties, strength, and unit stresses of structural steel.
14. Friday, December 18.
Paints. Corrosion of iron and steel. Composition of paints. Theory and application.

ZOOLOGY 4

PROFESSOR SCHMUCKER

The Principles of Animal Life

Lectures begin at 8 P. M.

1. Monday, January 4.
The Basis of Life. Protoplasm, the living jelly. The cell, the unit of life. Cell structure. Cell division.
2. Monday, January 11.
The Meaning of Environment. Not simply surroundings that affect. The fitness of the environment.
3. Monday, January 18.
Adaptation to Environment. Remarkable correspondence. Not usually perfect. Effect of a change in the environment.
4. Monday, January 25.
Adaptive Radiation. Central forms change in many directions. The Mesozoic reptiles. Tertiary mammals.

5. Monday, February 1.
   The Great Groups of Animals. Linnaeus and European museums. The two Latin names. Branch, class, order, family, genus, species. The main branches.
6. Monday, February 8.
   The Mendelian Theory of Heredity. Gregor Mendel and his garden. The effects of crossing. Dominant and recessive characters. Segregation.
7. Monday, February 15.
   Weismann and the Chromosomes. The study of the sheep-tick. The study of the nucleus. The machinery of heredity.

No lecture February 22.

8. Monday, February 29.
   Morgan and his Fruit Flies. Quick multiplication and many offspring. Great variation. Locating the genes.
9. Monday, March 7.
   Heredity and Environment. What is due to each. The two kinds of twins. What they teach us. Heredity furnishes possibilities.
10. Monday, March 14.
   The Early Evolutionists. The Greeks. The long lapse. Strange early conceptions. Lamarck and the effects of use and of disuse.
11. Monday, March 21.
   The Life Story of Charles Darwin. His desultory studies. His life out of doors. The voyage of the Beagle. The Galapagos Islands. The slow fruition. "The Origin of Species." Later writings. His death and burial in Westminster Abbey.
12. Monday, March 28.
   Darwin's Theory of Evolution. The rapid multiplication of animals. The threefold struggle for existence. The survival of the fittest.
13. Monday, April 4.
   The Development of the Evolutionary Theory. The need for isolation; which may be geographic or physiologic. Variation and mutation. Distribution.
14. Monday, April 11.
   The Future Evolution of Animals. The process still going on. Extinct animals. Disappearing animals. Hopeful lines.

GEOLOGY 1

PROFESSOR HOWELL

Physical Geography

Lectures begin at 7.45 P. M.*

1. Tuesday, January 5.
   Our Old Planet, the Earth. What it is made of and where it came from.
2. Tuesday, January 12.
   The Earth's Envelope of Air. What makes the weather change.
3. Tuesday, January 19.
   The Waters on the Earth. Oceans, seas, lakes, ponds, rivers, brooks, and springs.

* Please note the hour.

4. Tuesday, January 26.
   The High Portions of the Earth's Crust. Mountains, plateaus, high plains, and low plains.
5. Tuesday, February 2.
   The Deep Sea Basins. Their cold, watery world of perpetual night.
6. Tuesday, February 9.
   The Surface Waters of the Sea. The world whose inhabitants all float, drift, or swim.
7. Tuesday, February 16.
   The Shallow Waters of the Sea. The continental shelves and the oceanic platforms.
8. Tuesday, February 23.
   Islands. Continental islands and oceanic islands.
9. Tuesday, March 1.
   Australia, the Island Continent. Its vast desert basin and encircling mountain ranges.
10. Tuesday, March 8.
    Asia, the Largest Continent. The great northern plain, the mountain ranges on its borders, and the southern peninsulas.
11. Tuesday, March 15.
    Europe, the Flooded Continent. Its many arms and indentations.
12. Tuesday, March 22.
    Africa, the Hot Continent. Its high, dry uplands, parched deserts, huge rain-forest basin, and long rift valleys.
13. Tuesday, March 29.
    South America, the continent of great rivers and a mighty mountain range. The Andes, the tropical forests, and the southern plains.
14. Tuesday, April 5.
    North America, our own Continent. Its long parallel mountain ranges and the broad basins which stretch between them.

PHYSICS 2

PROFESSOR SEELY

Heat and Sound

Lectures begin at 8 P. M.

1. Wednesday, January 6.
   Heat Effects. Vibrations in matter. Molecular, mass, and atomic energy. Changes in (a) volume, (b) temperature, (c) molecular arrangement.
2. Wednesday, January 13.
   Changes in Temperature. Temperature sensation. Temperature measurements. Thermometers and thermometer scales.
3. Wednesday, January 20.
   Changes in Volume. Coefficient of linear expansion. Charles' Law. The absolute zero. Illustrations and application to building, refrigeration, etc.
4. Wednesday, January 27.
   Changes in Molecular Structure. Latent heat of fusion and of vaporization. Specific heat. Application to climate, etc.

5. Wednesday, February 3.
Transmission of Heat. Conduction, convection and radiation. Radiant energy. Infra-red and ultra-violet waves. The solar constant.
6. Wednesday, February 10.
Measurement of Heat Energy. The calorie and the British thermal unit. Transformation of energy and heat losses.
7. Wednesday, February 17.
Mechanical Equivalent of Heat. Mechanical equivalent. Laws of thermodynamics.

Sound

8. Wednesday, February 24.
Vibrations and Waves. Vibrating bodies. Simple harmonic motion. Transverse and longitudinal waves.
9. Wednesday, March 2.
Sound Sensation. Perception of sound. The ear. Limits of hearing. Noise and music.
10. Wednesday, March 9.
Properties and Behavior of Sound Waves. Velocity. Reflection. Echoes. Whispering galleries. Resonance.
11. Wednesday, March 16.
Properties of Sound Waves (Concluded). Sympathetic vibrations. Interference. Beats. Harmony and discord.
12. Wednesday, March 23.
Musical Sounds. Pitch. Intensity or loudness. Quality or timbre. Doppler's principle. Overtones. Resonators.
13. Wednesday, March 30.
Musical Sounds (Concluded). The musical scale. Melody, harmony, and rhythm.
14. Wednesday, April 6.
Musical Instruments. Laws of vibrating strings. Nodes and segments. Vibrating air columns.

MUSEUM TALKS

Monday Evenings at 7 o'clock

This series comprises informal talks, given on Monday evenings, illustrated by specimens in the Museum.

Miss Borden

Animals Without a Backbone

Sept. 14. One-celled and Many-celled Animals. The perforated body—Sponges.
Sept. 21. Sea Anemones and Jellyfishes.
Sept. 28. Corals and Coral Islands. The Attractions of a Coral Reef.
Oct. 5. Flat Worms; Round Worms; Red-blooded Worms.
Oct. 12. No lecture—Columbus Day.
Oct. 19. Starfishes and Sea Urchins. The Cucumbers and Lilies of the Ocean.
Oct. 26. Animals with Two Shells.
Nov. 2. Aristocrats with One Shell.

Professor Howell

Rocks

Nov. 9. Rocks: What they are made of and how and where they are formed.

Mr. Lawrence

Animals Without a Backbone but with Jointed Legs

Nov. 16. Crustaceans: Many Varieties. Life Histories and Interesting Habits.
Nov. 23. Economic Crustaceans: The Lobster and the Crab, etc.
Nov. 30. Insects: Life Histories, Orders, Adaptations. Farm and Forest Insect Pests.
Dec. 7. Insects: Household and Parasitic Insect Pests.
Dec. 14. Insects: Beneficial Insects, Silk Moth, Honeybee, Ichneumon Fly, Gall Insect.
Dec. 21. Spiders: Their Many Adaptations and Interesting Habits.
Dec. 28. No lecture—Christmas Holidays.
Jan. 4. Myriapoda: Thousand Leggers and Centipedes. Why They are of Interest.

Professor Howell

Minerals

Jan. 11. Minerals: Their Chemical Composition, Crystalline Form and Origin.

Professor Schmucker

Animals With a Backbone

Jan. 18. Water Living Vertebrates.
Jan. 25. Vertebrates Changing to Air Life.
Feb. 1. Cold-blooded Land Vertebrates.
Feb. 8. The Life of the Birds.
Feb. 15. The Great Groups of Birds.
Feb. 22. No lecture—Washington's Birthday.
Feb. 29. The Life of the Fur Bearers.
Mar. 7. The Great Groups of Fur Bearers.

Professor Howell

Fossils

Mar. 14. Fossils: How they Tell us About the Plants and Animals of the Past.

Professor Kaiser

Great Groups of Plants

Mar. 21. Liverworts and Hepatics. Lowly Plants of Moist Places.
Mar. 28. True Mosses. Their Place in Nature. The Peat Mosses and Their Uses. Andreaea.
Apr. 4. True Mosses (Concluded). Their Scientific Parts and Distribution. Acrocarpous and Pleurocarpous Species. Moss Collecting.
Apr. 11. Ferns: Vascular Cryptogams and Their Great Advance in Structure over Mosses. Historical Outline.
Apr. 18. Ferns (Concluded). Primitive and More Highly Developed Forms. Important Families. The Culture of Ferns.
Apr. 25. Fern Allies: Water Ferns. Horsetails. Club Mosses. Plants of the Past on the Threshold of the Phanerogams.
May 2. Gymnosperms or Naked Seeded Plants. Cycads. The Peculiar Gnetaceae. Ginkgo, Yew, Pine, Cypress, Cedar, Larch, Spruce, Fir and Juniper.

GENERAL SCHEDULE OF REGULAR LECTURES

Subjects of courses in each of the four successive years constituting a full term.

ENGINEERING

1. Materials of Engineering Construction.
2. Civil Engineering Structures.
3. Roads, Railroads and Tunnels.
4. Water Supply, Sewers, Canals, Rivers and Harbors.

PHYSICS

1. Properties of Matter. Mechanics.
2. Heat and Sound.
3. Light.
4. Electricity and Magnetism.

INORGANIC CHEMISTRY

1. General Principles, Notation, Nomenclature.
2. Descriptive Chemistry.
3. Descriptive Chemistry.
4. Descriptive Chemistry.

ORGANIC CHEMISTRY

1. General Principles, Aliphatic Hydrocarbons.
2. Carbohydrates, Fats, Oils and Waxes.
3. Cyclic Hydrocarbons.
4. Compounds Containing Nitrogen.

ZOOLOGY

1. Invertebrate Animals.
2. Vertebrate Animals.
3. Human Biology.
4. Principles of Animal Life.

BOTANY

1. Morphology.
2. Taxonomy.
3. Taxonomy (continued).
4. Physiology and Ecology.

GEOLOGY AND PALEONTOLOGY

1. Physical Geography.
2. Physical Geology.
3. Paleontology.
4. Historical Geology.

LECTURES UNDER RICHARD B. WESTBROOK FOUNDATION

1912.—Ancient Civilization of Babylonia and Assyria. *Morris Jastrow, Jr., Ph.D.*

1913.—Conservation of Natural Resources.
Gifford Pinchot, Marshall O. Leighton, Overton W. Price, Joseph A. Holmes.

1914.—The Theory of Evolution. *William Berryman Scott, Ph.D., LL.D.*

1915.—Invisible Light. *Robert Williams Wood, LL.D.*

1916.—Aspects of Modern Astronomy. *John Anthony Miller, A.B., A.M., Ph.D.*

1917.—Heredity and Evolution in the Simplest Organisms.
H. S. Jennings, B.S., A.M., Ph.D., LL.D.

1918.—The Chemistry, Nutritive Value and Economy of Foods.
Harvey W. Wiley, A.M., M.D., B.S., Ph.D., LL.D., D.Sc.

1919.—The Origin and Antiquity of the American Indian
Aleš Hrdlička, M.D., Sc.D.

1920.—Chemistry and Civilization. *Allerton S. Cushman, B.S., A.M., Ph.D.*

1921.—Microbiology. *Joseph McFarland, M.D., Sc.D.*

1922.—Evolution of the Human Face. *William K. Gregory, Ph.D.*

1923.—The Philosophy of Sanitation. *George C. Whipple, B.S.*

1924.—The Distribution of American Indian Traits. *Clark Wissler, A.M., Ph.D.*

1925.—Structural Colors. *Wilder D. Bancroft, Ph.D., Sc.D.*

1926.—The Animal Mind; its sources and evolution. *George Howard Parker, Sc.D.*

1927.—An Interpretation of Atlantic Coast Scenery. *Douglas W. Johnson, Ph.D.*

1928.—The Science of Musical Sounds. *Dayton C. Miller, Ph.D.*

1929.—Volcanoes and Vulcanism. *William B. Scott, Ph.D., LL.D.*

1930.—Present Problems of Evolution. *Edwin Grant Conklin, Ph.D., ScD., LL.D.*

1931.—The Problems of the Origin and Antiquity of the American Aborigines in the Light of Recent Explorations. *Aleš Hrdlička, M.D., Sc.D.*

WESTBROOK FREE LECTURESHIP PUBLICATIONS

Can be purchased through any book-store

Ancient Civilization of Babylonia and Assyria, by *Morris Jastrow, Jr.* J. B. Lippincott Co.

The Theory of Evolution, by *William Berryman Scott.* The Macmillan Co.

Life and Death, Heredity and Evolution in Unicellular Organisms, by *H. S. Jennings.* Richard G. Badger.

Chemistry and Civilization, by *Allerton S. Cushman.* Richard G. Badger.

Fighting Foes too Small to See, by *Joseph McFarland.* F. A. Davis Co.

The Relation of Nature to Man in Aboriginal America, by *Clark Wissler.* Oxford University Press.

PUBLICATIONS OF THE INSTITUTE

TRANSACTIONS

Vol. 1.—Explorations on the West Coast of Florida and in the Okeechobee Wilderness. *Angelo Heilprin.* $2.50

Vol. 2.—Report on Fresh-water Sponges Collected in Florida. *Edward Potts.*
Notice of Some Fossil Human Bones. *Joseph Leidy.*
Description of Mammalian Remains from Rock Crevice in Florida. *Joseph Leidy.*
Description of Vertebrate Remains from Peace Creek, Florida. *Joseph Leidy.*
Notice of Some Mammalian Remains from Salt Mine of Petite Anse, Louisiana. *Joseph Leidy.*
On Platygonus, an Extinct Genus Allied to the Peccaries. *Joseph Leidy.*
Remarks on the Nature of Organic Species. *Joseph Leidy.* $1.00

Vol. 3.—Parts 1, 2, 3, 4, 5, 6.—Contributions to the Tertiary Fauna of Florida. *William H. Dall.* $15.75

Vol. 4.—Fossil Vertebrates from the Alachua Clays, Florida. *Joseph Leidy.* $1.25

Vol. 5.—Study of Hawaiian Skulls. *Harrison Allen.*
Notes on the Palæontological Publications of Prof. William Wagner. *William H. Dall.* $1.00

Vol. 6.—Selenodont Artiodactyls of the Uinta Eocene. *William B. Scott.* $1.00

Vol. 7.—Contributions to the Mineralogy of the Newark Group in Pennsylvania. *Edgar T. Wherry.*
A Comparative Study of the Radio-Active Minerals in the Collection of the Wagner Free Institute of Science. *Carl Boyer and Edgar T. Wherry.* $0.50
Vegetation of South Florida. *John W. Harshberger.* $2.50
Studies in Carbohydrates. *Charles H. LaWall and Sara S. Graves.* $0.50

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John Wagner, Jr., *President*

ANNOUNCEMENTS

THE Board of Trustees, on October 20, 1931, elected John Wagner, Jr., President of the Institute.

Professor Wagner, who succeeds his father, the late Samuel T. Wagner, is, like his father, an engineer, graduating as a Bachelor of Science in Engineering from the University of Pennsylvania in 1913, being awarded the degree of Civil Engineer by the same institution in 1920.

He began his engineering career as a draftsman with the Phoenix Bridge Company, and in 1916 entered the office of Bridges and Buildings of the Pennsylvania Railroad, with which road he was connected until 1921. His service with the railroad was interrupted by enlistment in the U. S. Army, in which he served with distinguished gallantry as First Lieutenant and Captain in the Cavalry during the World War. After the armistice he returned to the railroad, and in 1921 was appointed Asst. Supervisor of Track of the Reading Company, and in 1926, Supervisor.

In 1928 the Reading Company opened a new department, and elected Mr. Wagner Industrial Agent of the Company, which position he now holds.

Professor Wagner's first interest in the Institute began as a boy when he accompanied his father to lectures given in the hall of the Institute. Professor Wagner was elected a Trustee of the Institute in 1920. In 1921 he was appointed lecturer in Engineering, and in 1926 was made a member of the Faculty with a full Professorship. During the period from 1920 to the present date he was successively Secretary and Treasurer of the Board, and on October 20 became President.

President Wagner is an associate member of the American Society of Civil Engineers, a member of the American Railway Engineering Association, and a member of the American Railway Development Association. He also holds a commission as Captain in the 51st Railway Battalion of the United States Army (Reading Company).

Mr. Wagner is a young man of energy and ideas, and under the leadership of his forceful personality the Institute will not only hold its position in the educational field of Philadelphia, but will stride forward to even greater attainments.

At the same meeting at which the new President was elected, the Board elected Mr. David E. Williams, Jr., and Dr. Sydney L. Wright, Jr., as Trustees to succeed Samuel T. Wagner and Henry Leffmann, deceased.

Mr. Williams is President of the David E. Williams Coal Company, and a director of the Philadelphia Saving Fund and of the Corn Exchange National Bank. He is a great, great nephew of the founder of the Institute, and is a man of wide experience in business and banking.

Dr. Wright is a direct descendant of James Logan, who was prominent in the early history of Philadelphia. He is a graduate of Princeton University, where he later obtained his Ph.D. degree, and is at present engaged in research work in the Department of Research Medicine of the University of Pennsylvania.

EXPERIMENTS IN THE PARAFFINE INFILTRATION OF MARINE WORMS

By John G. Hope, Wagner Free Institute of Science

Introduction

The following experiments were carried out with a view to determining the adaptability of marine worms to the paraffine infiltration method of preservation. Habitat groups illustrating such invertebrates have been neglected largely because of the expense of reproducing them in wax, celluloid or glass. We thought, therefore, that the development of some less expensive method, such as the one of paraffine infiltration, might prove to be an incentive to an increase in exhibition of such material.

Methods

All material was collected at Stone Harbor, N. J., by dredging and digging the mud flats at low tide. The specimens were put into jars of sea water as soon as collected.

Identification was made at the time of collection. Specimens were then killed, in a manner which would offer the least chance of undue contraction, by placing them in stender dishes of sea water and spraying the surface of the water with chloroform at five-minute intervals until anesthesia ensued. Fully expanded specimens were obtained in most cases. Irritation with a needle provided a check on the time required for complete anesthesia.

When no response was gotten from such irritation the specimens were placed in 5% Formol for a few minutes to harden. They were then wrapped individually in cheese-cloth, tagged, and placed in a stock solution of fixer in the collecting case, and in this manner were shipped to the laboratory. The less fragile specimens were injected both with formol and fixer by means of a hypodermic syringe. Great care was taken, however, not to exert much pressure on the plunger, as this tends to burst the specimen.

The fixer used was Gilson's:

Nitric acid	1.5 c.c.
Glacial acetic acid	0.5 c.c.
Corrosive sublimate	2 grams
Alcohol (60%)	10 c.c.
Distilled water	88 c.c.

Immediately upon reception at the laboratory dehydration was begun. Gradually increasing strengths of alcohol were used, i. e., 28%, 50%, 67%, 82%, and 95%. A rather thorough draining should be permitted between each change to prevent dilution of the next strength of alcohol. Several changes of 95% alcohol were used

to insure thorough dehydration. This step must be carried out carefully, as much of the success of the infiltration depends on it.

Terpineol was used to replace the alcohol. An old, used bath of this may be used to remove most of the alcohol from the specimens, and a clean dishful used to complete the operation. This method serves the purpose well and is more economical.

When the alcohol was removed, the terpineol was, in turn, replaced by xylene. An old and a clean bath of this may be used in the same way as the terpineol. Complete extraction of the terpineol may be determined by the absence of diffusion currents caused by the mixing of the liquids of different densities. It is very necessary that the terpineol be *completely* replaced by the xylene.

The specimens were now ready for imbedding in paraffine. This was effected by a mixture of equal parts of paraffine and xylene. Such a mixture was made by melting the paraffine, adding the xylene, and allowing the mixture to settle to a thin paste, stirring occasionally. The specimens, which up until this time had remained in the cheese-cloth, were now unwrapped and imbedded in the mixture. Care must be taken not to break the specimens during this operation, as the xylene has a tendency to "freeze" them and make them brittle. One or two days allow sufficient time for imbedding, depending on the size of the specimen.

The dishes holding the specimens were then heated slightly to melt the imbedding mixture, the specimens removed and placed in dishes of pure paraffine in a constant temperature oven. The paraffine should have an M.P. of 54° C. and be kept at about 60° C. One or two days is sufficient time for the completion of infiltration. The specimens should be looked at occasionally to see that they are all completely submerged in the paraffine.

A great deal of the appearance of the specimens depends on the next process—finishing. As they came out of the oven they were easily worked into the desired pose. Any shrinking or appearance of hollows was remedied by the use of a warm hypodermic syringe loaded with hot paraffine. The syringe may be kept warm by passing it through a Bunsen flame. At first a great deal of trouble was caused by the paraffine clinging to the setae of the worms, but this was offset by the expedient of placing the specimen on the warm-plate, and brushing off the paraffine with a warm camel's-hair brush. After the specimen was thus cleaned and posed it was plunged into a dish of cold water, which set the paraffine. Upon removal from the water any excess paraffine that still persisted was removed by brushing with xylene. Any changes in pose may be made by slightly warming the specimen over a low flame or on the warm-plate.

Unfortunately, most of the color was lost in the process. It is the writer's belief that this was due to the fixer used. Much experimenting could still be done in investigating the effects of various fixers. The one suggested by Noble* may prove more successful, but we have not tried it. It is possible that even with a better fixer the color would be lost in the subsequent operation of dehydration, but no matter what the cause it was found necessary to tint the specimens to give an entirely natural appearance. Oil color was used with xylene as a vehicle. This proved to be very successful, the paraffine absorbing the xylene which carried the color with it. A ground color was put on first, and touching up and spotting done later. The use of xylene as a vehicle seems to cut to a minimum the obvious "painted" appearance of all tinted specimens. The tinting finished, the specimen is ready to go into its proper place in the group.

Results

The results on the whole were satisfactory. The loss of color was unfortunate, but casts and models must be painted anyway, and the infiltration method still obtains as the better of the two. It is certainly more economical. *Glycera americana* gave probably the best results, and when tinted was very natural and life-like in appearance. *Clymenella torquata* was a close second, and one specimen in particular was very typical. *Nereis pelagica* gave fair results, while *Sipunculus gouldii* gave very good results, with the exception of the tentacles, which persisted in clinging together. They were so delicate that any attempt to separate them after infiltration met with disaster. Aside from this they were quite satisfactory. *Lumbriconereis opalina* was the black sheep of the series. It is exceedingly brittle, and succeeded in contracting and coiling violently despite the anesthetic. It also lost much of its beautiful opalescent color, and altogether the finished product lacked much of the appearance of the living worm. *Diopatra* was used successfully in a habitat group.

Conclusion

It would seem from the above described experiments that the paraffine infiltration method of preserving marine worms is preferable to the casting and modeling method. It is much more economical, as the technician does not have to be so highly skilled in particular arts as in casting in celluloid, modeling in glass, etc. The cost is also greatly cut by the decrease in time necessary to produce the fin-

* American Museum Novitiates, Nov., 1926.

ished specimens. It is far superior to the old method of preserving in alcohol, as in this case all semblance of color is lost, the form is often distorted, and in many cases the glass container further distorts the appearance of the specimen. If habitat work is not contemplated, the specimens may be placed in cardboard trays and labeled. They are dry, hard, and may be handled with reasonable care at any time. There is no question as to their permanency.

Unfortunately, we did not have time to extend the experiments to other classes of invertebrates, but do not doubt that it would prove satisfactory in many cases. Interesting subjects would be the Echinoderms, Holothurians, and possibly some of the Salpoids. Another interesting field would be in the preservation of invertebrate dissections, by making the dissection of say a star fish or a clam first, hardening in formol, and running it through the process.

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ANNOUNCEMENTS

ATTENDANCE at lecture courses in 1931 increased 17% over the year previous, while attendance at Museum Talks increased 5½%.

The Publication Committee announces that sales of Dr. Fenton's book, "Studies of Evolution in the Genus Spirifer," have been very satisfactory. On February 5th the Institute had the pleasure of listening to Dr. Fenton on the subject, "Rambles in Old Canada," being an account of the observations of a geologist who went fossil hunting. The lecture was delivered under the Fannie Frank Leffmann Memorial Lectureship.

Mr. Dan McCowan, of Banff, who was so well received two years ago, lectured under the same Lectureship on February 26th. His subject was, "In the Land of the Assiniboin Indian."

Dr. George Flowers Stradling, Emeritus Professor of Physics of the Institute, died on January 24th, after a brief illness. Dr. Stradling's connection with the Institute began in 1896 as a lecturer, and in 1899 he was elected to the chair of Physics, which he occupied with distinction until 1911, when he was made Emeritus Professor of Physics. Dr. Stradling's career both as a physicist and as an educator was marked by brilliance and conscientious performance of duty.

TWO NEW CAMBRIAN TRILOBITES FROM VERMONT

By B. F. Howell, A.M., Ph.D.

During the past hundred years paleontologists have been searching about in the sedimentary rocks that were deposited in the Cambrian Period, 500,000,000 to 600,000,000 years ago, to find fossils which would tell them what the plants and animals of that time were like. The search has been very successful, and much has been learned about Cambrian life and, incidentally, about Cambrian geography.

One of the interesting facts which the paleontologists have unearthed in this search is that the animals of MesoCambrian days which lived in the seas of the Northern Hemisphere (and all the Cambrian animals whose fossils have been found were marine, no trace of any land animal of that period having been discovered) were apparently more or less segregated in two great life provinces. One of these provinces included what we now think of as the North Atlantic region. The other embraced the vast North Pacific realm. Throughout the North Atlantic region, in Morocco, Spain, France, Germany, Czechoslovakia, Poland, Scandinavia, Great Britain, Newfoundland, southeastern Canada, and eastern Massachusetts, paleontologists have found the remains of faunas which were of one general sort, while in western North America and eastern Asia the fossils unearthed have been those of faunas of another kind. The most characteristic species of the faunas of the North Atlantic region were members of the genus of large trilobites which has been named *Paradoxides*, while the commonest species found in the North Pacific realm belonged to other genera, *Paradoxides* seeming never to have spread to that part of the world.

For many years it seemed to the paleontologists that the marine faunas of these two great life provinces were almost entirely distinct. In recent years, however, evidence has been found proving that the faunas were not so greatly different as they had earlier appeared to be. The scientists have therefore been trying to discover whether the two great ocean basins—the North Atlantic and the North Pacific—were directly connected in MesoCambrian times, so that marine animals could migrate from the one to the other, or whether the migrations which seem to have taken place were long, roundabout ones. In attempting to secure evidence on this problem students of the Cambrian have been searching around the edges of

the North Atlantic province, in eastern North America, to determine how far westward the typical North Atlantic MesoCambrian faunas ranged.

The fossilized remains of MesoCambrian faunas, with their typical genus, *Paradoxides*, have been known, for more than half a century, to be present in the Middle Cambrian rocks of southeastern Newfoundland, southeastern New Brunswick, and eastern Massachusetts; but for many years no trace of such faunas could be found west of those areas. Many Cambrian fossils were discovered in the Appalachian Mountains, from Vermont to Alabama, but none of them contained species of *Paradoxides* or other genera characteristic of the North Atlantic MesoCambrian faunas.

Finally, however, about twenty-five years ago a few fossils which seemed to belong to a "*Paradoxides* fauna" were discovered in northwestern Vermont, much to the surprise of most American geologists and paleontologists, who had about made up their minds that faunas of this type had never succeeded in invading the marine troughs in which the sediments that are now the older Paleozoic rocks of the Appalachian Mountains were deposited. But only a few of these fossils were found; and, because the geology of northwestern Vermont is very complicated, and was not at that time clearly understood, their exact character and significance were not then determined.

Recently the writer has undertaken to learn more about these interesting fossils and the rocks in which they are entombed. He has succeeded in gathering much new information concerning them. Some of this new information has been published,[1] some is presented herewith, and more will be published later.

The fossils found have all proved to belong to a single fauna of late MesoCambrian age. It is the first fauna of just this age to be discovered in North America, and is therefore of unusual interest to American paleontologists. Among the species found in it are representatives of two genera of trilobites which are of especial interest, because one of them, *Centropleura*, has not hitherto been reported from continental North America, and the other, *Elyx*, has never

[1] Problematical fossil, possibly a fish plate, from the Cambrian *Paradoxides* beds of northwestern Vermont. Bull. Geological Soc. America, vol. 37, 1926, p. 236.

Cambrian *Paradoxides* beds in northwestern Vermont. Bull. Geological Soc. America, vol. 37, 1926, pp. 242–243.

The finding of the St. Albans Cambrian "fish-plate." Fifteenth Rept., Vermont State Geologist, 1927, pp. 121–124.

The Cambrian *Paradoxides* beds of northwestern Vermont. Sixteenth Rept., Vermont State Geologist, 1928, pp. 249–273.

Cambrian "*Paradoxides*" fauna of northwestern Vermont. Bull. Geological Soc. America, vol. 42, pp. 346–347.

before been discovered in the Western Hemisphere. The discovery of species of these two genera in Vermont has been announced by the writer,[1] but no description of these species has been published. They are therefore described and figured on page 7. Both are from the late MesoCambrian St. Albans Formation, or from pebbles of that formation in the NeoCambrian Mill River Conglomerate, near the city of St. Albans, in Franklin County, northwestern Vermont. A new subfamily, the Centropleurinae, is also here proposed, to include the trilobites which have been referred by authors in the past to the genus *Centropleura*.

FAMILY, CONOCORYPHIDAE ANGELIN
SUBFAMILY, CTENOCEPHALINAE HOWELL
GENUS, ELYX ANGELIN
ELYX AMERICANUS HOWELL

Fig. 1

Elyx americanus Howell. 1931. Geological Soc. of America, Preliminary List of Titles and Abstracts of Papers to be Offered at the 44th Ann. Meeting, p. 55.

Only the cranidium of this species has been discovered, and no very well-preserved examples of it have been found. The best example is figured here. Only faint indications of transverse glabellar furrows are visible on this cranidium. The test of the whole shield appears to have been smooth.

This species differs from *Elyx laticeps* Angelin, which lived in the Scandinavian region in late MesoCambrian times, in having a narrower glabella with weaker transverse furrows, and probably in other details which can not be seen in the few imperfect specimens of *Elyx americanus* that we have.

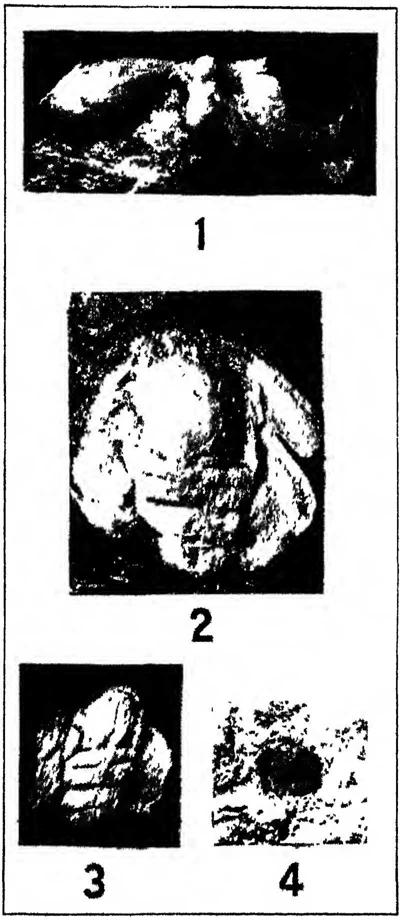
The holotype of this species is No. 9880a in the paleontological collection of Princeton University. Paratypes are Nos. 9881 and 9882 in the same collection.

FAMILY, PARADOXIDAE EMMRICH
SUBFAMILY, CENTROPLEURINAE, NEW SUBFAMILY

The members of this subfamily differ from the other members of the family Paradoxidae in having the brim on the front of the cranidium widely extended laterally, while the facial suture cuts far in toward the glabella behind this extended portion of the shield, and also in possessing a short anterior furrow on each side of the

[1] Discovery of the Cambrian trilobite genus *Elyx*, in America. Geological Soc. of America, Preliminary List of Titles and Abstracts of Papers to be offered at the 44th Ann. Meeting, 1931, p. 55.

glabella that runs diagonally backward, instead of across, as the other glabellar furrows do. The pygidium of members of this subfamily bears two or more spines on each side.



1. Elyx americanus (holotype).
2–4. Centropleura vermontensis. Figure 3 is the holotype.
The figures are twice natural size.

Genus Centropleura Angelin

Centropleura vermontensis Howell

Figs. 2–4

Paradoxides sp. Perkins, 1908. Rept., State Geologist of Vermont for 1907 and 1908, p. 209.

Paradoxides harlani Green, Walcott, 1910. Smithsonian Misc. Coll., vol. 53, No. 6, pp. 254, 255, text figs. 10 and 11.

Centropleura sp. Howell, 1931. Bull. Geol. Soc. America, vol. 42, pp. 346, 347.

Centropleura vermontensis Howell, 1931. Geol. Soc. of America, Preliminary List of Titles and Abstracts of Papers to be Offered at the 44th Ann. Meeting, p. 55.

Cranidium: The glabella is evenly rounded in front, and is moderately convex. The second and third glabellar furrows are deeper than the fourth furrow and the neck furrow.

Free cheeks, hypostome, and thorax. The few fragmentary examples of the free cheeks, hypostome, and thorax that have been found indicate that these parts of the body were more or less similar to those of *Centropleura lovéni* Angelin.

Pygidium: There are two spines on each side. The ribs and furrows on the pleural lobes and the three transverse furrows on the axis are shallow.

This species differs from *Centropleura lovéni*, which lived in the Scandinavian region in late MesoCambrian times, in having the front of the glabella evenly rounded, rather than ovally pointed, and in the fact that the second and third transverse furrows extend all the way across the glabella, instead of being broken in the middle.

The holotype of this species is No. 9809 in the paleontological collection of Princeton University. Paratypes are Nos. 9810-9817, 9819–9836, 9838–9848, 9876, 9939, 9996, 9997, 40059, and 40061 in the same collection, and 13416-13420 and 13435 in the paleontological collection of the Peabody Museum of Natural History of Yale University.

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Vol. 11.—Biochemistry of American Pitcher Plants. *Joseph S. Hepburn, Elisabeth Q. St. John and Frank M. Jones.* $2.50

PUBLICATIONS

Vol. 1.—A Revision of the Ostracod Genus *Kirkbya* and Subgenus *Amphissites.* *Robert Roth.* $1.00

Vol. 2.—Studies of Evolution in the Genus Spirifer. *Carroll Lane Fenton.* $6.00

BULLETIN

Bulletin of the Institute. Quarterly $1.00 per year
Single numbers, 25 cents.

Republication of Conrad's Fossils of the Medial Tertiary of the United States. Introduction by *William H. Dall.* (Out of Print.)

ANNOUNCEMENTS

At the Closing Exercises held in the auditorium May 11th the largest class in the history of the Institute, numbering 137, was graduated. After the exercises Dr. Roy Waldo Miner, Curator of Marine Life, American Museum of Natural History, delivered an illustrated lecture on "Exploring Coral Forests."

The 1932 Westbrook Free Lectureship Course, "Common Sense, Science and Philosophy," delivered by Dr. John Dewey, Professor Emeritus in Residence, Columbia University, in April, was very successful. Over two thousand persons attended the lectures. A résumé of the lectures is given on the following pages.

The Institute is pleased to state that research work in Biology has been begun by Professor S. C. Schmucker, the results of which will be announced from time to time.

A RÉSUMÉ OF FOUR LECTURES ON

COMMON SENSE, SCIENCE AND PHILOSOPHY

Delivered by JOHN DEWEY

Professor Emeritus in Residence, Columbia University, under the Richard B. Westbrook Free Lectureship Foundation at The Wagner Free Institute of Science, April 1, 2, 8, and 9, 1932

LECTURE I—COMMON SENSE

There are two different meanings of the words "common sense." Two philosophies have claimed to be founded on common sense. Berkeley had said that matter did not exist. Hume had said the self did not exist. The Scotch philosophers, at a loss to meet these views, fell back on common sense, which assures us of the existence of matter and of self. To them common sense was the power which conceives truth and wins assurance by instinctive belief. This process was too simple in its way of getting rid of problems, and could not last. Spontaneous belief is poor evidence of reality. According to common sense the sun runs about a stationary earth. All general conceptions, scientific or religious, seem to be based on common sense. Both science and philosophy question this conception of common sense. Science has questioned a stationary earth and also the fixity of species, which seemed to rest on common sense. Philosophy similarly questions many seemingly common sense beliefs.

But there is another way of looking at common sense. This is to consider it as consisting of sound practical judgments, general sagacity. Both science and philosophy have a more practical, less hostile relation to common sense considered in this particular way.

The philosophy which interests me most results from observations anyone can make every hour of his daily life, and not on those technicalities which can only be considered by specialists furnished with technical devices. Certain judgments are forced on man by the situation in which he finds himself. The present tendency is to feel that philosophy should be based on scientific observations.

Where does philosophy start? Whence does it get its data? Bertrand Russell says mathematics furnishes the only proper material on which to base philosophy. Charles Peirce, a well-trained laboratory worker, started with evident facts as the most certain basis and went last to mathematics. Shall philosophy start with the common materials near at hand or with the more abstract intellectual results of thinking? I think that philosophy should start with the common experiences. But here there is a difficulty. The commoner and more familiar things are, the harder they are to deal with philosophically. We lose consciousness of things that are quite familiar. We do not hear the loud clock to which we are used, but we notice the instant it stops.

It is not aspersion to say that the philosopher turns things upside down to look at them. He must see them from an unusual viewpoint.

Another difficulty is that each of us comes to an object with ready formed judgments that we think are common sense when they are only early acquired and long held ideas. The wearer of blue glasses does not know what things are really blue. A large part of philosophy consists in getting rid of these presuppositions. The painter talks of recovering the innocence of the eye. The philosopher must recover the innocence of the mind. What are some of the most common traits of our world of common sense? This world of common objects is not one in which the intellectual element is important, but is one to

be used and enjoyed. The philosopher is concerned with looking at things from the intellectual side and not for their enjoyment or use. In this he differs from the ordinary man.

The present general interest in science is very late. Every new scientific inquirer naturally meets hostility and often persecution, because he seems to get so far away from the common way of using and enjoying.

Language began not for its usefulness but as an overflow of joy and hilarity, somewhat in the nature of song. It was not invented to convey thought. This is probably also true of all early activities.

Classic philosophy was based on this point of view. In the twelfth century Aristotle's philosophy was taken up by the church and is still widely taught by the Catholic Church. It looks on the world as to be used and enjoyed, and on thinking as a joy of the mind. It seeks the purpose of everything. Hence final causes were sought for rather than generative causes. It was a philosophy of qualities. Things were used in accordance with their qualities: hard and soft, light and heavy, wet and dry, hot and cold, were such qualities. Combinations of these made up the four elements. For two thousand years this mode of thinking prevailed and formed the backbone of religious beliefs. For only the last two hundred years has there been a real scientific attitude of thought.

LECTURE II—SCIENCE

Up to the seventeenth century there was little recognized difference between philosophy and science, and both of them were nearer the ordinary thinking. Modern science deals with sizes and velocities which are quite beyond ordinary perception.

The Greeks are unjustly spoken of as not being observers. Their art and their architecture show this to be a mistake. Truly they were too closely tied to observation and did not go to indirect observation or into calculation. They had only the unaided eye. Their discoveries were simple additions of the old kind of materials. There seemed to them no place for progress in a finished world. This state of mind lasted until modern times.

Roger Bacon made question of all this, as later did Francis Bacon. The latter proposed a new kind of science, with a new method, leading to the relief and perfecting of the human estate. With prophetic vision the Bacons both anticipated many modern inventions.

Modern science is the product of observation as aided with modern inventions and methods of calculation. The growth of the crafts and the collection of materials for medicines contributed much. So also did the search for the elixir of life and the transmutation of the base metals into noble. The exploration of new worlds in the sixteenth and seventeenth centuries contributed much to the new method of science. So also did the taking up from other countries of paper making and of printing from movable type. Gunpowder had come through the Moslems from the Chinese as also had the compass. The lens and the pendulum were also new tools. Astronomy took a new turn with the lens. The pendulum gave new accuracy to measurements of time.

The newly borrowed Arabic numerals made calculation far easier. Algebra, again borrowed from the Arabs, gave added capacity for calculation. Then the invention of analytical geometry and of the calculus made possible more complex mathematical calculations. The science of today owes far more to our instruments, physical and mathematical, than to any supposed higher brain power.

Greek philosophers lacked manual dexterity because manual work was delegated to slaves. Mechanical inventions, if made, seemed to them rather in the nature of toys.

Modern science is experimental because of new tools borrowed from the

craftsman. Only then did ability to know prove related to ability to make. When men manufactured and analyzed water they first knew what it was. The Greek philosophers looked for the purpose, the end, as explanation of the thing —the final cause. Modern science cares for the generating causes—how things are made—how they happen. This begins to lead to control. When you know how a thing happens you are in the way of finding how to make it happen.

A less obvious consequence follows. What are the objects studied by physical science? For example, is color in the object or in the eye? The Greeks never doubted that any quality belonged to the object. Science now knows that color is due to certain wave lengths of light. Thus taste, temperature, and so forth, are not inherent in the object. Do we know the thing in itself, the reality?

What we ask of science is not so much knowledge of the inner nature of things as power of prediction and of control. You look at a barometer to foretell coming weather, but you do not think of the weather as originating in the barometer.

The scientific world is not a rival of our commonly perceived world, but it gives us control or prediction of phenomena, to which we then adjust ourselves.

We need not fear that science will take away our enjoyment of the world as it is, but it gives the intellectual tools for reshaping this world.

LECTURE III—PHILOSOPHY

Philosophy is concerned with beliefs. They are the raw material of Philosophy. Philosophy has been defined as premature science. We overlook the fact that hypotheses are the forerunners of all science. Science insists that speculations be confirmed. No great scientific work has been done by merely collecting facts. Newton got his idea of the formula for gravitation by a guess and then collected facts to substantiate the guess. Darwin's theory was founded in the same way. There is, however, another function of philosophy. This aspect is suggested in the original Greek meaning of the word—love of wisdom. Wisdom means knowledge plus. Some people accumulate knowledge but are not wise. Philosophy once expressed a certain way of living in Greece two thousand years ago, in the banding together into schools. This old stoic idea of the philosopher still survives to a certain extent.

A philosophy is a certain way of adjusting one's self to the world in which we live—making an adjustment through ideas. If any philosophy is genuine it will give one a certain intellectual balance. In one sense, philosophy is an intellectual recipe for being at home in the world. More fundamental beliefs are the direct object of philosophy. What do we mean by belief? By etymology, "belief" is "beloved." Belief is that which we would rather have so and is connected with our English word "love." Belief means trust or confidence in something or somebody. Belief means a kind of going out of our emotions or will to the object, so that we commit ourselves to it. One kind of judgment is intellectual. Other judgments are concerned not simply with facts but with values. Strictly scientific judgments have nothing to do with the value of objects with which they deal. The immediate object of philosophy lies in our fundamental judgment of values. Philosophy should be based on science. Bertrand Russell holds that mathematics is the most perfect kind of science. Philosophy should be lined up then conclusively with mathematics. Therefore, philosophy has nothing to do with social affairs. Herbert Spencer said philosophy is completely unified knowledge, while science is only partially unified. Philosophers have to accept the findings of scientists

on the nature of the world and then to frame the judgments of value and to determine what we are to do in the world.

There is a real division of labor between the philosopher and the scientist. Philosophy tells us what these scientific facts mean, and what course of action we should pursue. When philosophy is thought of as a kind of science, it has misled many. In the first place, philosophy is not a form of knowledge in the sense that science is. Again, philosophy depends on science. Objection has been brought against philosophy that it does not go ahead like science and that philosophers do not agree among themselves. Men may agree about facts, but they cannot agree about the values of life. Men see life from different angles. Philosophy tries to make differences of education and of experience more clear so that men may be conscious of just the angle from which they are seeing life. Study of the history of philosophy has value because it broadens the intellectual and moral outlook of the student. I do not think it possible to exclude the element of choice. We have to make a choice and act upon it. While philosophy is not a kind of science it must depend on science to get its picture on which to act. Science is very modern and is still a very thin crust which overlaps traditions which have come down from the past. The older views still persist in a certain amount of debris which civilization keeps in its garret. Science itself means the adoption of a certain attitude, the experimental attitude, of a searching, inquiring mind which accepts conclusions only on the basis of evidence. This experimental attitude of mind has not made much of a dent in modern culture, political views or moral conceptions. The older, prescientific attitude of mind prevails.

In the third place, there are leading concepts of science. Older science taught that rest was more important than change; that change was in itself an evidence of a lack of full realization of reality. Modern science has taught us that we live in a world in which change is inevitable. If modern minds would completely accept this idea of change and if we would trust ourselves, we might be better able to direct the change.

LECTURE IV—THE RETURN TO COMMON SENSE

You will remember that common sense has a double significance. It may mean belief in ideas that have come down so long and are so widespread that we are apt to think that no one of common sense can doubt them. To this philosophy has a negative if not a destructive attitude. The other meaning—judgments about the common things of life—seems to be just horse sense, good judgment, appreciation of real values. With reference to these values philosophy is a critic and a guide. It is not a dictator, but it helps us to judge discriminatingly. It gives us a more intelligent attitude.

Scientific observations are of great assistance to philosophy in forming these judgments.

Common sense is concerned with the qualities of things which give us the use, enjoyment, purposes for which we employ them. But attitude to things is commonly practical rather than intellectual. This is natural. We have bodies which we must adjust to our surroundings if we are to have intellectual enjoyment.

If we accept evolution we know our brains and nervous systems did not originate for intellectual purposes, but simply to make adjustment to our environment. In contrast with this, the whole development of physical science tended to eliminate these qualities and give us a world of electrons, of energy, while what we call qualities depend really on the effect of these motions on our bodies. Science now gives quantities and measures and deals much less in the qualities which make the world enjoyable to us.

This gives us a mechanistic idea of the world, which seems to rob us of our

well-known universe. It makes the world seem hard and cold, even hostile. But science interests us in the aspects of things which help us to predict and to control. Science, which seemed at first to destroy values, makes them in reality more secure. In the old view Nature seemed closer than it does today, because it seemed purposeful. It seemed as if there was an inner vitality always striving to reach its destined end, which was perfection. But there was a distinct limitation in this old view. Man could not help the process; he must simply accept these inherent ends. When science removed the idea of these ends the world became more serviceable to us. The purposive activities were taken out of the world, which yielded to the purposes of man. Man changed animals and plants nearer to his needs. This is just as true of inventions, as they relate to metals and the forces of nature, which can be controlled to man's ends. This process is still only partial in the short portion of human existence during which there has been any real science. The future possible advances in this line may well be believed to be enormous. Discovery is still rather haphazard and accidental.

Let us apply these ideas to human freedom. The old idea was that human freedom depended on understanding and on insight. The Greeks thought of a few of themselves as having this freedom beyond all others. These others were creatures of appetite and impulse. Plato described a slave as one who was not capable of framing an end which could control his own life. Hence only the intellectual aristocrat was fit to rule.

There are doubtless differences in intellectual capacity, but not such differences as the Greeks imagined. Everyone not an imbecile or a moron is sufficiently intelligent to bring certain conditions under control. Such is also the case in social life. If democracy is possible it is because every individual has a degree of power to govern himself and be free in the ordinary concerns of life. If not, there must be either anarchy or dictatorship.

Through increase of knowledge and of science we should be able to work out a technique, effective to develop this power in man.

The older philosophy considered thought as a thing in itself, the product of pure reason. We still have "pure" science as different and higher than applied science. This view prevails in wide circles. But the pure scientist is not pure. He must find actual facts to corroborate his pure conceptions. In this he is like the painter and the poet. Not all applications are such as may be financially profitable. Philosophy is a mode of thought and it too must find embodiment and application. It cannot rival science in its application to railways and radios. It applies more fully to human life, especially to social life. Education is either by routine, descended from the past, or it receives intellectual guidance from philosophy.

It is not the part of philosophy, as past thinkers held, to solve the problem of evil and to justify the ways of God to man. The real problem of evil is not to account for evil but to show how to control and lessen it.

Philosophy may be conceived as a process of devising methods and hypotheses for the improvement of human life. It will not stop with analyzing and classifying as science does, but must devise ends worth striving for, and must find what resources we have for accomplishing these ends.

Historic idealism has been the attempt to prove that the world already is spiritual and measures up to our highest ideals. Now we practically consider one an idealist who sets to work to find the methods and resources by which life may be improved. The real demand of philosophy should be for idealism of this latter sort, which, through legislation, education, economics, devotes itself to discovering how ideas of betterment may be carried out.

This seems to some a derogation for philosophy, but I think this change will take place in philosophy just as it did in science. Application tests and confirms philosophy.

BULLETIN

OF THE

WAGNER FREE INSTITUTE OF SCIENCE

OF

PHILADELPHIA

VOLUME VII, NO. 3, AUGUST, 1932

ANNOUNCEMENT

FOR

SESSION OF 1932-33

EIGHTY-FIFTH YEAR

WAGNER FREE INSTITUTE OF SCIENCE OF PHILADELPHIA

SEVENTEENTH STREET AND MONTGOMERY AVENUE

PHILADELPHIA, PA., U. S. A.

THE WAGNER FREE INSTITUTE OF SCIENCE
Montgomery Ave. and Seventeenth St.

BULLETIN

of the

WAGNER FREE INSTITUTE OF SCIENCE OF PHILADELPHIA

PUBLISHED BY THE INSTITUTE

SYDNEY L. WRIGHT, JR., *Editor*

Vol. 7 No. 3	Quarterly August, 1932	$1.00 per year Single numbers, 25 cents

WAGNER FREE INSTITUTE OF SCIENCE

Montgomery Ave. and Seventeenth St., Philadelphia, Pa., U. S. A.

HISTORICAL NOTE

The Wagner Free Institute of Science owes its establishment to the liberality and public spirit of William Wagner and his wife, Louisa Binney Wagner. In his early life Professor Wagner made extensive voyages in the service of Stephen Girard, and had opportunities to visit scientific institutions and make the acquaintance of scientific workers. He soon developed a strong interest in the natural sciences, especially geology and mineralogy, and devoted a large part of his life to studying these topics and collecting material to illustrate the teaching of them.

In 1847 he began to give free lectures at his home, near the present location of the Institute building, at that time in the rural section of the county. In 1855 the Institute was incorporated by the Legislature, a faculty was appointed and lectures were given at Commissioners' Hall, Thirteenth and Spring Garden Streets, by permission of the city authorities. In a few years the city was obliged, by its own needs, to withdraw the privilege of the hall, and Professor Wagner arranged to erect a suitable building on his own property. This was completed in May, 1865, and lectures at once given in it. In 1864 a deed of trust was executed by Professor Wagner and his wife, furnishing a permanent endowment of the Institute.

In 1885, by the death of the founder, the care of the Institute passed into the hands of a Board of Trustees, since which time many improvements have been made in the building, and extensive additions to the equipment in the museum and library and in scientific apparatus. In 1901 a wing was built for the use of a branch of the Free Library of Philadelphia.

FACILITIES FOR INSTRUCTION

Lectures and Class-Work

Instruction at the Wagner Free Institute of Science is conducted by means of public lectures, supplemented by class-work, and is without charge and without restriction of race or sex. The class-instruction is given partly at the close of each lecture, partly by written exercises. The Museum and Reference Library of the Institute are available for aid in the instruction work and are freely used. In addition, the Wagner Institute Branch of the Free Library of Philadelphia affords abundant opportunities for collateral reading.

At the close of each course of lectures an examination is held, to which those who have attended the classes are admitted, and on passing such examination the pupil is awarded a certificate. Certificates are awarded at a public meeting held in May of each year.

The lecture courses are arranged to cover a given topic in four

successive years, and to those who hold certificates for each of these courses a full-term certificate is issued.

Museum

The Museum covers the whole field of natural science and contains illustrations in all departments of biology, geology, mineralogy, metallurgy, and engineering. The specimens are arranged so as to be easily studied and are open to inspection from 2 to 5 o'clock Wednesday and Saturday afternoons, except legal holidays.

Teachers with classes and others desiring to use the museum for special studies can, by applying at the office, gain admission any week-day, except holidays, as above stated, between the hours of 9 A. M. and 5 P. M.

The collections of the museum have been used for a number of years for instruction by means of "Museum Talks," as noted below, and by arrangement with work at Temple University and the Division of Science Teaching of the Board of Public Education those teaching General Science in the eighth and ninth grades of the Philadelphia public schools or preparing for such teaching may secure elective credits upon the completion of the work as follows:

General Science II

Monday,	7 P. M. to 8 P. M.	Museum Lecture.
	8 P. M. to 9 P. M.	Lecture Course—Botany and Zoology.

NOTE: Four semester hours of credit will be given for the complete Monday evening program.

Tuesday,	8 P. M. to 9 P. M.	Lecture Course—Inorganic Chemistry and Geology.
Wednesday,	8 P. M. to 9 P. M.	Lecture Course—Organic Chemistry and Physics.

NOTE: An additional two semester hours of credit per evening may be obtained by electing Tuesday or Wednesday evening.

Monday evening is a prerequisite for these, however.

Further information concerning these courses may be obtained at the Office of the Institute.

Libraries

The Reference Library contains text-books and works of reference in all departments of science, encyclopedias, many works devoted to literature, and an assortment of dictionaries of English, classical and foreign languages. It is open on all regular business days from 9 A. M. to 9 P. M., a librarian being in attendance to assist students.

The Circulating Library is a branch of the Free Library of Phila-

delphia. It is open every business day from 9 A. M. to 9 P. M. Books may be taken out under the usual rules of the Free Library. Many periodicals—American and foreign, scientific and literary—are on file.

BULLETIN

The BULLETIN of the Institute is quarterly. It contains information as to the methods of work of the Institute, announcements of additions to its collections and original contributions to science. The seventh volume is now in course of publication. The subscription price is $1.00 per year, single copies, 25 cents.

SPECIAL LECTURES

By the liberality of Richard Brodhead Westbrook, D.D., for many years a trustee of the Institute, and of his wife, Henrietta Payne Westbrook, provision has been made for lectures independent of the general courses of the Institute and covering a wide range of topics. A list of lectures so far given and of publications thereof so far as issued is printed on page 35.

Announcement of the course for 1933 will be made in a subsequent issue of the BULLETIN.

The income of a fund given by Dr. Henry Leffmann is applied to providing special lectures as the Fannie Frank Leffmann Memorial Lectureship.

The *Philadelphia Natural History Society* meets on the third Thursday of each month, except June, July and August. These meetings are open to all persons interested in the subjects.

RESEARCH

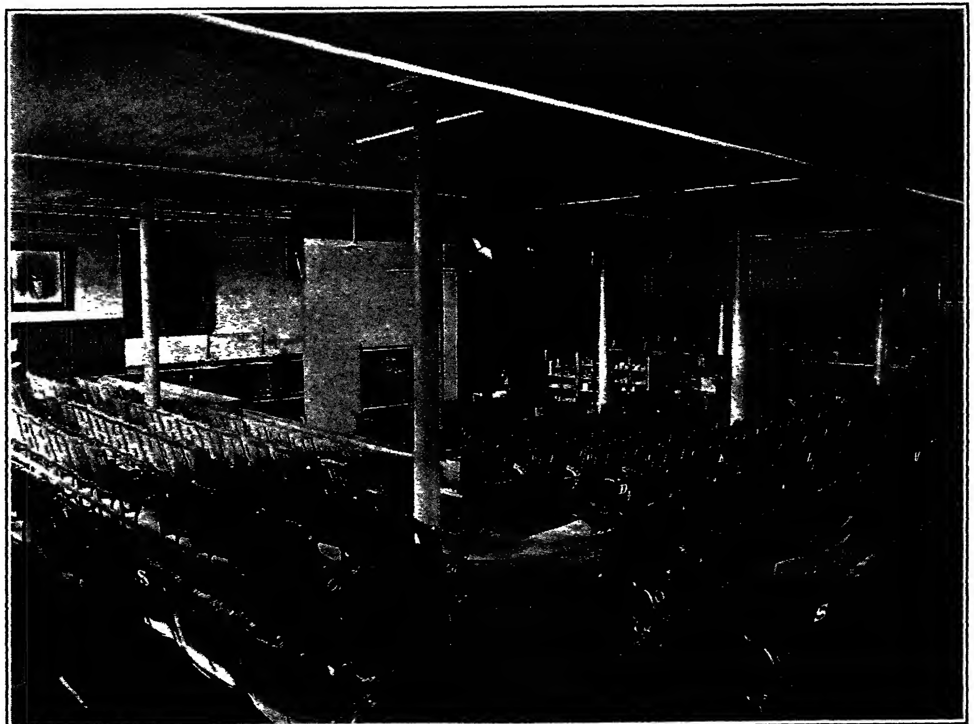
The Institute has carried on research work since 1885, most of the results having been published in its Transactions and Publications. A list of these will be found on page 36. Results of research appear also from time to time in the BULLETIN.

The Henry Leffmann Chemistry Research Fund has been established for perpetual service.

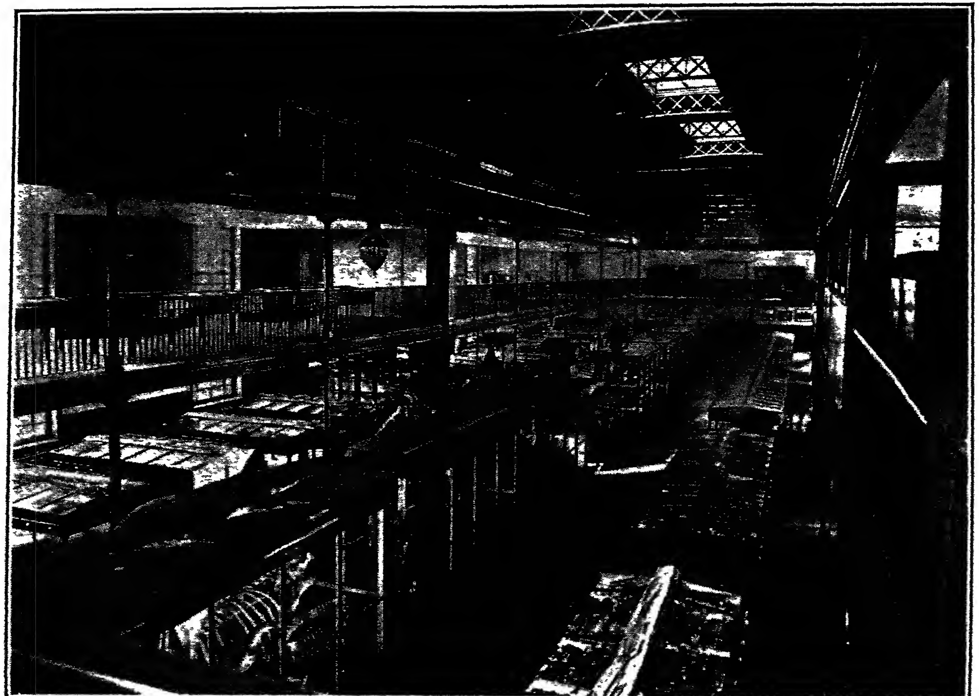
CLOSING EXERCISES

In May of each year the courses of instruction are formally closed by a public meeting at which addresses are given and the certificates awarded.

At the closing exercises in May, 1932, after an address by Professor Ivor Griffith, Secretary of the Faculty, and awarding of certificates, Dr. Roy Waldo Miner, Curator of Marine Life, American Museum of Natural History, delivered a lecture entitled, "Exploring Coral Forests."



Auditorium



MUSEUM

FULL TERM CERTIFICATES AWARDED

ENGINEERING

Alfred W. Fischer
John J. Kyle

INORGANIC CHEMISTRY

H. L. Grabosky
John G. Hope

GEOLOGY

William Heck
John G. Hope
Dr. Henry Winsor

BOTANY

Harry A. Lloyd
Mrs. Helen G. Toner

ZOOLOGY

Emanuel Hocking
Florence McIlravey

1931–1932 CERTIFICATES AWARDED

ENGINEERING 1

Everett R. Curry
Henry V. Deppisch
Harry Erstad
Alfred W. Fischer
Edward I. Fitzgerald
Edward H. Gillette
William D. S. Gillette
Clifford G. Goodridge
John J. Kane
John J. Kyle
Francis J. Maurer
Arthur H. Smith
Joseph J. Treacy
William K. Williams

BOTANY 1

Myra H. Burford
Harry W. Fischer
William D. S. Gillette
Emanuel Hocking
Herman H. Hofeld
Harry A. Lloyd
Guy H. McKeown
Mrs. Reba A. G. Mimms
Fannie A. Root
Herbert F. Schearer
Herbert F. Schearer, Jr.
Mrs. Maud H. Schearer
Ned H. Schearer
Henry Singer
George M. Snyder
Charlotte L. Temple
Mrs. Helen G. Toner
William K. Williams

INORGANIC CHEMISTRY 3

John Dick, Jr.
John F. Glenn
H. L. Grabosky
Herman H. Hofeld
John G. Hope
Sergius T. Kobernick
Joseph J. Kolb
Samuel S. Leiter
William Pavlo
Mrs. Josephine M. Wild
William K. Williams

ORGANIC CHEMISTRY 3

Jane M. Byer
Grace F. Campbell
Ruth H. Duke
William D. S. Gillette
John F. Glenn
Stewart Gray
J. Oakley Hendry
Herman H. Hofeld
Frank P. Ingenito
Florence V. Johnston
John J. Kane
Kathryn B. Kennedy
Samuel S. Leiter
William W. Melody
Elnora C. Merritts
Mrs. Reba A. G. Mimms
Marie J. Oscar
William Pavlo
Mary I. Simonton
Norman W. Trew
Sue K. Walker
Louise Wiedmann
William K. Williams

ZOOLOGY 4

Mrs. Winifred L. Bardsley
Edmund S. Barker
Jacob Braunstein
Raymond D. Downey
Helen I. Duffy
Harry W. Fisher
Wilma E. Gaines
Walter H. Gardner
George Gordon
Mrs. Marie B. Gordon
Emanuel Hocking
Herman H. Hofeld
John C. R. Hofferbert
Frank P. Ingenito
John J. Kane
Joseph J. Kolb
Mary A. Leonard
Joseph Marfisi
Arthur F. Maurer
Florence McIlravey
Mrs. Reba A. G. Mimms
Mrs. Maud H. Schearer
Henry Singer
George M. Snyder
Francis Speight
Charlotte L. Temple
Dr. Henry Winsor

GEOLOGY 1

John H. Antrim
Edmund D. Barker
Harry W. Fisher
Wilma E. Gaines
William Heck
Herman H. Hofeld
John G. Hope
John J. Kane
Reuben R. Lobel
Francis J. Maurer
Clifton V. Mimms
Mrs. Reba A. G. Mimms
Harold B. Poole
John W. Quinn
William E. Schlesman
Henry Singer
Charlotte L. Temple
John H. Turri
William K. Williams
Dr. Henry Winsor

PHYSICS 2

Jacob Braunstein
Edgar A. Burt
John S. Cooper
Charles S. Danser
John F. Glenn
Herman H. Hofeld
John J. Kane
Joseph J. Kolb
Samuel S. Leiter
Charlotte L. Temple
Norman W. Trew
William K. Williams
Dr. Henry Winsor

FACULTY

SAMUEL CHRISTIAN SCHMUCKER

A.M., M.S., Sc.D., Muhlenberg College.
Ph.D., University of Pennsylvania.
For thirty years Professor of Biological Sciences, State Teachers College, West Chester, Pa.
For twenty years head of Science Department, Summer Schools, Chautauqua, N. Y.
For fifteen years Lecturer on Biology, Brooklyn Institute of Arts and Sciences.
Professor of Botany, Wagner Free Institute of Science, 1908–1926.
Professor of Zoology, Wagner Free Institute of Science, 1926 to date.
Dean of the Faculty.
Author of
"The Study of Nature." (Lippincott Co.)
"The Meaning of Evolution."
"Man's Life on Earth."
"Heredity and Parenthood." (Macmillan Co.)

JOHN WAGNER, JR.

B.S. in C.E. 1913, University of Pennsylvania.
C.E. 1920, University of Pennsylvania.
Assoc. M., Am. Soc. C. E.
1913–1916, Draftsman, Phoenix Bridge Company.
1916–1921, Office of Engineering Bridges and Buildings, Pennsylvania Railroad, including two years' service with the Army as First Lieut. and Captain in the Cavalry.
1921–1926, Assistant Supervisor Track, Reading Company.
1926–1928, Supervisor Track, Reading Company.
1928 to date, Industrial Agent, Reading Company.
Professor of Engineering, Wagner Free Institute of Science, 1926 to date.

LESLIE BIRCHARD SEELY

Graduate, State Normal School, Bloomsburg, Pa.
Taught school, Luzerne and Snyder Counties, Pa.
Assistant instructor in physics and chemistry, Bloomsburg, 1899–1902.
Graduate, Haverford College, 1905.
Head Master, Friends Institute, Chappaqua, N. Y., 1905.
Instructor in physics, Northeast High School, Philadelphia, 1906–1915.
Head of Science Department, Germantown High School, 1915–1923.
Principal, Roxborough High School, 1923–1924.
Principal, Germantown High School, 1924 to date.
Graduate courses, University of Pennsylvania and Brooklyn Institute, 1906–1910.
Honorary degree of Doctor of Pedagogy, Ursinus College, 1926.
Professor of Physics, Wagner Free Institute of Science, 1912 to date.
Publications:
"Description of Two New Distomes," Biological Bulletin, Lancaster, Pa., 1906.
"Ether Waves and the Messages They Bring."
"The Physics of the Three-electrode Bulb," Transactions of the Wagner Free Institute of Science.

DAVID WILBUR HORN

A.B., Dickinson College, 1897.
A.M., Dickinson College, 1898.
Ph.D., Johns Hopkins University, 1900.
Assistant in Chemistry, Johns Hopkins University, 1900–1901.
Associate and Associate Professor of Chemistry, Bryn Mawr College, 1901–1907.

Lecturer in Hygiene, Hahnemann Medical College, 1911 to date.
Head of Pre-Medical School of Science, Hahnemann Medical College, 1916–1921.
Professor of Physics and Physical Chemistry, Philadelphia College of Pharmacy and Science, 1921 to date.
Professor of Inorganic and Physical Chemistry, Wagner Free Institute of Science, 1911 to date.
Chairman of Philadelphia Section of American Chemical Society, 1904 and 1905.
Fellow of American Association for the Advancement of Science.
Fellow of the Royal Society of Arts of London.

IVOR GRIFFITH

Early education at the Bethesda Academy, Wales, and came to America in 1907.
P.D., Philadelphia College of Pharmacy and Science, 1912.
Ph.M., Philadelphia College of Pharmacy and Science, 1921.
Director of Research, John B. Stetson Company.
Director of Laboratories, Stetson Hospital.
Editor, American Journal of Pharmacy.
Assistant Professor of Pharmacy, Philadelphia College of Pharmacy and Science.
Professor of Organic Chemistry, Wagner Free Institute of Science, 1926 to date.
Secretary of the Faculty of Wagner Free Institute of Science.
Publications:

"Recent Remedies," 1926 (revised 1928).
"Popular Science Lectures" (Editor) (eight volumes).
U. S. Dispensatory (Collab. Editor).
Formula Book, A. Ph. A. (Editor).
Contributor to current chemical, pharmaceutical and medical literature.

GEORGE BRINGHURST KAISER

Educated in private schools.
Graduate, Franklin School.
After graduation spent several years in intensive botanical study and field work in northeastern United States.
Secretary of the Botanical Society of Pennsylvania for seven years and leader of its field trips; at present is First Vice-President of the Society.
Instructor in Botany, School of Horticulture for Women.
Professor of Botany, Wagner Free Institute of Science, 1927 to date.
Curator, Moss Herbarium, Sullivant Moss Society.
Treasurer, Delaware Valley Naturalists' Union.
Member, Academy of Natural Sciences.

BENJAMIN FRANKLIN HOWELL

B.S., A.M., Ph.D., Princeton University.
Associate Professor of Geology and Paleontology, Princeton University.
Professor of Geology and Paleontology, Wagner Free Institute of Science, 1927 to date.
Curator of Invertebrate Paleontology in Princeton University.
Fellow of the Paleontological Society.
Secretary of the Paleontological Society.
Fellow of the Geological Society of America.
Fellow of the American Association for the Advancement of Science.
Associate Member of the Paleontological and Mineralogical Division of the American Association of Petroleum Geologists.
Member of the Sub-committee on Micropaleontology of the National Research Council.
Editor of the section of General Paleozoology of *Biological Abstracts*.
Specializes in Cambrian Paleontology and Geology.
Associated with U. S. Geological Survey, the U. S. National Museum, Geological Survey of Canada, Canadian National Museum, Geological Survey of Vermont, Geological Survey of Montana, as a consulting paleontologist and research associate.

REGULAR LECTURES, SESSION OF 1932–1933

BOTANY 2

PROFESSOR KAISER

Taxonomy

Lectures begin at 8 P. M.

1. Monday, September 12.
   Myxomycetes. Slime moulds. The borderland of plants and animals. Amoeba-like plasmodia. Sporangia of delicate structure and color. Habitat and life history.
2. Monday, September 19.
   Cyanophyceae. Blue-green algae. Early organisms of simple structure upon the cooling earth-crust. Algae of hot springs and arctic regions. Coloring of the Red Sea. The peculiar Nostoc.
3. Monday, September 26.
   Schizomycetes. Bacteria. Types and kinds. Aerobe and anaerobe. Their good and bad traits toward man. Important human and plant diseases in the group. Plants that fix nitrogen.
4. Monday, October 3.
   Chlorophyceae. Phycomycetes. Green algae and algal fungi. Pond scum, desmids and diatoms. Volvox. Moulds and mildews. Sexual processes. Oögonia and antheridia. Conjugation.
5. Monday, October 10.
   Phaeophyceae. Rhodophyceae. Brown and red seaweeds. Giant kelp. Rockweeds and the Sargasso Sea. Irish moss and dulse. Color in relation to light supply. Economic uses.
6. Monday, October 17.
   Ascomycetes. Sac fungi. Truffle, Morel and Peziza. Chestnut tree blight and other plant diseases. Ferment organisms: saccharomycetes. Moulds. Complicated sexual development showing derivation from red algae.
7. Monday, October 24.
   Lichenes. Lichens. Dual organisms composed of algae and fungi. Symbiosis or helotism(?). Soil building and reproduction. Soredia and ascospores. Curious uses. Litmus, rock tripe, reindeer moss.
8. Monday, October 31.
   Basidiomycetes. Basidio-fungi. Scientific classification of the group. Smuts of corn, wheat, oats, and onion. Heteroecism: plants that live on two hosts. Rust of wheat, white pine blister rust and cedar apple. Other orders.
9. Monday, November 7.
   Basidiomycetes (Continued). Gilled fungi: the field mushroom and its kin. Edible and poisonous forms. Death Angel and Fly Agaria. Coral, spinous and bracket fungi. Puff balls and stink-horns. Phosphorescent species.
10. Monday, November 14.
    Hepaticae. Liverworts. Green plants that have acquired a land habit. Alternation of generations. Gametophyte and sporophyte. Antheridia and archegonia. Sporangia and elaters. Thalloid and foliose forms. Development of stomata.

11. Monday, November 21.
Musci. True mosses. Green spore-bearing plants. Soil-formers. Protonema and gametophyte. Development of sporangia. Calyptra, operculum, peristome and annulus. Peat mosses. Andreaea. The order Bryales.
12. Monday, November 28.
Filices. True ferns. Life history. Prothallium. Sori and sporangia. Adder's tongue and moonwort. The Polypody family. Lime-loving species. Wall-rue, cliff brake and walking fern.
13. Monday, December 5.
Other Pteridophyta. Fern allies. Water ferns, salvinia, horsetails, club mosses and their kin. Fossils of the coal measures. Heterospory. Pteridosperms.
14. Monday, December 12.
Gymnosperms. Naked-seeded plants. Life histories. Cycads and ginkgo, sole surviving representative of a once important family. The long-lived yew. Pines and other conifers. Gnetaceae and the remarkable Welwitschia of the African desert.

Field Trip

Saturday, December 10, 1932

The class in Botany will be conducted through Horticultural Hall, Fairmount Park, under the leadership of Professor Kaiser. Party will meet at the west entrance of Horticultural Hall at 2 P. M.

INORGANIC CHEMISTRY 4

PROFESSOR HORN

Chemistry of the Metals

Lectures begin at 7.45 P. M.*

1. Tuesday, September 13.
Iron. Metallurgy: ore, mineral, gangue, flux, slag. Cast iron, white and gray. Wrought iron. Steels: open hearth, Bessemer, crucible. Tempering. Case-hardening.
2. Tuesday, September 20.
Iron (Continued). Chemical properties of iron. Ferrous and ferric compounds. Analytical recognition. Photochemical properties. Blue printing. Biologic importance. Ink.
3. Tuesday, September 27.
Copper. Principal ores. Native copper. Refining. Alloys. Chemical properties. Analytical recognition. Biologic occurrence. Electric cell.
4. Tuesday, October 4.
Lead. Principal ores. Parke's process. Pattisonizing. Cupellation. Fire assay. Atomic weights of lead. Alloys. Chemical properties. Analytical recognition. Biologic effects. Storage batteries.
5. Tuesday, October 11.
Mercury. Principal ores. Preparation. Refining. Amalgams. Chemical properties. Analytical recognition. Mercurous and mercuric compounds. Biologic effects. Fulminating mercury.

* Please note the hour.

6. Tuesday, October 18.
   Gold and Platinum. Occurrence. Placer deposits. Free-milling ores. Cyanide process. Toning. Gold leaf. Alloys of gold; of platinum. Chemical properties. Platinum sponge. Platinum black. Catalysis.
7. Tuesday, October 25.
   Silver. Sources. Cupellation and parting. Plating. Alloys. Cleaning silver. Chemical properties. Analytical recognition. Biologic effects. Lunar caustic, colloidal silver, silver nitrate, indelible ink. Photosensitiveness. Daguerreotypes. Wet plates. Dry plates and films.
8. Tuesday, November 1.
   Cobalt and Nickel. Sources. Carbonyls. Mond process. Electro-deposition. Alloys. Monel metal. Chemical properties. Edison storage battery. Metal-ammines. Principal and secondary valence. Werner's hypothesis.
9. Tuesday, November 8.
   Cadmium and Tin. Sources. Metallurgy. Liquation. Alloys. Fusible metals. Chemical properties. Analytical recognition. Mordants. Tin salt. Tin plate and terne plate. Corrosion of metals. Recovery of tin.
10. Tuesday, November 15.
    Tungsten and Titanium. Sources. Chemical properties. Tungsten steel. Titaniferous iron ores. Tungsten filaments. Other uses.
11. Tuesday, November 22.
    Metallography. The phase rule. Eutectics. Thermal analysis. Determination of formulas of compounds neither isolated nor analyzed. Solid geometry of chemistry.
12. Tuesday, November 29.
    Bismuth and Molybdenum. Sources. Alloys. Chemical properties. Analytical recognition. Basic salts. Phosphomolybdates, and arsenomolybdates. Complex inorganic acids. Molybdenum steel.
13. Tuesday, December 6.
    Uranium and Rarer Metals. Sources. Chemical properties. Uranyl compounds. Transformation of elements. Emanations. Transmutation of metals. Modern alchemy.
14. Tuesday, December 13.
    Metallic Poisons. Industrial poisons. Germicides. Insecticides. Everyday hazards due to toxicity of metals.

ORGANIC CHEMISTRY 4

PROFESSOR GRIFFITH

Compounds of Nitrogen

Lectures begin at 8 P. M.

1. Wednesday, September 14.
   Nitrogen Itself. Inert alone but restless in company. An essential ingredient of all living tissue. Proteins. Classification. Identification. General characteristics.
2. Wednesday, September 21.
   Proteins. Their rôle in animal diet. Protein foods. Calorific value. Important proteins—gluten, gelatin, casein, etc.

3. Wednesday, September 28.
   Protein Derivatives. The body's way of simplifying the complex proteins by its schemes of digestion. Pepsin, trypsin, etc.
4. Wednesday, October 5.
   Protein Derivatives (Continued). Amino-acids, proteoses, peptones. The cinders of protein digestion—urea, creatinin, etc.

No lecture October 12.

5. Wednesday, October 19.
   The Cycle of Nitrogen in Nature. Changing simple inorganic nitrogen compounds to complex organic bodies—and reverse. The nitrate beds of Chile. Soil and soil nutrition.
6. Wednesday, October 26.
   Man's Conquest of the Air. Not with wings, but with brains. Nitrogen fixation. Nitrogen—inactive—inert and useless—chained and put to work. The Haber process. Other fixation processes.
7. Wednesday, November 2.
   Miscellaneous Nitrogen Compounds. Vitamines and hormones. Regulators of living processes.
8. Wednesday, November 9.
   Miscellaneous Nitrogen Compounds (Continued). Purines, amines, urea, caffeine, theobromine and other odds and ends of nitrogen compounds.
9. Wednesday, November 16.
   Miscellaneous Nitrogen Compounds (Concluded). The cyanogen compounds. Plants that are poison factories. The bitter almond, wild cherry, peach, and hydrogen cyanide. Cyanamide.
10. Wednesday, November 23.
    Alkaloids. General characteristics. Origin—their rôle in plant life. Group reactions. Adsorption phenomena. Color reactions.
11. Wednesday, November 30.
    Alkaloids (Continued). The Pyridine and Tropine group—Coniine—the Socratic poison. Nicotine—the democratic poison. Atropine—the mydriatic poison. Cocaine—the anæsthetic poison.
12. Wednesday, December 7.
    Alkaloids (Continued). The Quinoline and Iso-quinoline groups. Quinine—bark of Peru, made famous by Jesuit fathers. Strychnine—the toxic and tonic alkaloid. Morphine, codeine, hydrastine, etc.
13. Wednesday, December 14.
    Alkaloids (Concluded). Artificial and miscellaneous alkaloids. Apomorphine, homatropine, heroine, emetine from ipecac, and sanguinarine from blood root.
14. Wednesday, December 21.
    Ptomaines and Allied Compounds. Ptomaines—toxins and toxalbumins. Facts and fallacies of food poisoning.

ENGINEERING 2

PROFESSOR WAGNER

Civil Engineering Structures

Lectures begin at 8 P. M.

1. Friday, September 16.
   Foundations on Land. Designing the footing. Preparation of the bed.
2. Friday, September 23.
   Foundations on Land and Water. Foundations on piles. Cofferdams.
3. Friday, September 30.
   Foundations in Water. Open caisson process. Dredging through wells. Pneumatic caissons.
4. Friday, October 7.
   Masonry Construction. Stone masonry. Concrete. Brick masonry. Retaining walls, piers, etc.
5. Friday, October 14.
   Framing in Wood and Steel. Wood framing. Iron and steel framing. Joints. Rivets. Pins.
6. Friday, October 21.
   Bridges. Definitions. Classification. History. Beam bridges.
7. Friday, October 28.
   Bridges (Continued). Plate girders.
8. Friday, November 4.
   Bridges (Continued). Trusses. Classification. Design of tension and compression members.
9. Friday, November 11.
   Bridges (Continued). Trusses (concluded). Details and methods of erection. Cantilevers.
10. Friday, November 18.
    Bridges (Continued). Suspension. Tubular. Arches—(a) stone, (b) steel.
11. Friday, November 25.
    Bridges (Concluded). Movable bridges. Viaducts.
12. Friday, December 2.
    Roofs. Types of trusses. Special designs for train sheds.
13. Friday, December 9.
    Details of Construction. Rivets. Riveted work, pins, forging details. Bridge floors—(a) railroad, (b) highway.
14. Friday, December 16.
    Buildings. Design of buildings of wood, steel, reinforced concrete, general building construction.

ZOOLOGY 1

PROFESSOR SCHMUCKER

Invertebrate Animals

1. Monday, January 9.
   How Plants and Animals Differ. No single sharp difference. Plants commonly fixed: animals commonly motile. Plants usually make their own food: animals find it ready made.
2. Monday, January 16.
   Animals of a Single Cell (Protozoa). Have all the powers of higher animals, in lowly development. Necessarily small. Immense numbers and rapid increase. Basal food for higher animals.
3. Monday, January 23.
   Where the Colony Submerges the Individual (Porifera). Hard to tell what is the individual. Shape and size indefinite. The supporting skeleton. Bath sponge the skeleton of a colony.
4. Monday, January 30.
   The Foundation for Higher Life (Coelenterata). The developed digestive system. Mouth surrounded by tentacles that select food. The fixed polyp and the floating jellyfish. Alternation of generations. The coral skeleton.
5. Monday, February 6.
   Good Organs with Little Guidance (Echinodermata). Digestive glands and a separate outlet. Developed nervous system. Water-filled feet. Radiate form with little preference.

No lecture February 13.

6. Monday, February 20.
   Gaining a Sense of Direction (Vermes). Bilateral symmetry the result of forward motion. The development of brain. The segmented body. The absorbing skin, leading to parasitism. The three great groups.
7. Monday, February 27.
   Animals Attached to their Homes (Mollusca). The two-shelled clams. Lines of growth. The one-shelled snails. The nautilus and the squids. Furnish man much food.
8. Monday, March 6.
   Active Animals without a Backbone (Arthropoda). Marked segmentation. Sense organs on head. Outside skeleton and jointed legs. Three great groups based on their breathing.
9. Monday, March 13.
   Water-breathing Arthropoda (Crustacea). Daphnia and the barnacles. Crayfish, lobsters and crabs. Food for many higher forms, including man.
10. Monday, March 20.
    Tube-breathing Arthropoda (Tracheata). The belated slime-slug. Thousand leggers and hundred leggers. The six-legged insects. Compound and simple eyes. Variability, abundance and destructiveness.
11. Monday, March 27.
    Old and Lowly Insects. The wingless group. Hoppers and walking-sticks. Protective shapes and colors. The mating call. The harmless dragonfly. Bugs and their sucking beak. The incomplete metamorphosis.

12. Monday, April 3.
    Newer and Higher Insects. The two-winged flies. House-fly and mosquito. Beetles and their hardened front wings. Butterflies and flowers. The complete metamorphosis.
13. Monday, April 10.
    The Co-operative Insects. Wasps, bees and ants. Lowest forms solitary. Progress to social life. The only true stings. Nectar and honey.
14. Monday, April 17.
    Spiders and their Allies (Arachnida). The lung-book. Eight eyes and eight legs. The poison glands. The spinning glands and the web. Harvestmen, mites and ticks. King-crabs.

Field Trip

Saturday, April 15, 1933

The class in Zoology will be conducted through the Public Aquarium, Fairmount Park, under the leadership of Professor Schmucker. Party will meet at the Aquarium, 26th and Green Streets, at 2 P. M.

GEOLOGY 2

PROFESSOR HOWELL

Physical Geology

Lectures begin at 7.45 P. M.*

1. Tuesday, January 3.
   The Ever-Changing Earth. Its constant efforts to settle down permanently, and why it never succeeds in doing so.
2. Tuesday, January 10.
   What is Inside of the Earth? Theories regarding the earth's interior and what happens there.
3. Tuesday, January 17.
   Molten Rocks. How they become molten, and how they cool and freeze.
4. Tuesday, January 24.
   Lavas Which Break Through to the Surface. Volcanoes, fissure eruptions, geysers, and hot springs.
5. Tuesday, January 31.
   What Makes the Earth's Face Look so Weatherbeaten. How the elements furrow and line it and wear it away.
6. Tuesday, February 7.
   Weathering and Chemical Solution. How rocks are broken up and dissolved by natural agents at and near the surface of the ground.
7. Tuesday, February 14.
   Transportation by Wind and Water. How the broken and dissolved rocks are moved from place to place.
8. Tuesday, February 21.
   Transportation by Ice. Glaciers, ice-caps, and icebergs, and how they carry freight.

* Please note the hour.

9. Tuesday, February 28.
   Deposition. The formation of sedimentary deposits at the end of the transportation systems.
10. Tuesday, March 7.
    Sedimentary Rocks. How they are formed. The fossils which they contain.
11. Tuesday, March 14.
    Movements of the Earth's Crust. Earthquakes, faults, and folds.
12. Tuesday, March 21.
    How the Rocks of the Earth's Crust are Changed by these Movements. Metamorphic rocks. Marbles, quartzites, and schists.
13. Tuesday, March 28.
    How the Topography of the Earth's Surface is Changed as a Result of These Movements. How mountains, valleys, plateaus, and plains are made.
14. Tuesday, April 4.
    Underground Waters. Hot waters and cold waters and what they do down in the earth's crust.

Field Trip

Saturday, April 8, 1933

The class in Geology will be conducted on a field trip under the leadership of Professor Howell. Owing to the difficulty of arranging a schedule in advance, details of time and place will be announced later.

PHYSICS 3

PROFESSOR SEELY

Light

Lectures begin at 8 P. M.

1. Wednesday, January 4.
   Historical Development of Theory of Light. Corpuscular theory. Newton. Electro-magnetic wave theory. Huygens and Maxwell. Galileo. Rumford.
2. Wednesday, January 11.
   Propagation of Light. Travels in straight lines. Intensity of light. Law of variation. Shadows.
3. Wednesday, January 18.
   Propagation (Continued). Brightness and illumination. Photometry. Speed of light.
4. Wednesday, January 25.
   Interference and Polarization. Nature of a beam of light. Description of interference phenomena. Polarized light.
5. Wednesday, February 1.
   Reflection of Light. Law of reflection of light. Mirrors and diffusing surfaces. Plane mirrors.
6. Wednesday, February 8.
   Reflection (Continued). Curved mirrors. Formation of images, real and apparent.

7. Wednesday, February 15.
   Refraction. Passage of light through media of varying densities. Lenses and prisms. Formation of images by lenses.

No lecture February 22.

8. Wednesday, March 1.
   Dispersion of Light. Composition of white light. Complementary colors. Pigments.
9. Wednesday, March 8.
   Color Phenomena. Coloration by absorption and by reflection. Opalescence. Phosphorescence. Fluorescence.
10. Wednesday, March 15.
    Spectra. The solar spectrum. Fraunhofer's lines. Bright-line and dark-line spectra. The spectroscope.
11. Wednesday, March 22.
    Spectra (Continued). Infra-red and ultra-violet light. Composition of the sun's light. Artificial lights.
12. Wednesday, March 29.
    Optical Instruments. Magnifying glass. Compound microscope. Telescope.
13. Wednesday, April 5.
    Optical Instruments (Continued). The projection lantern and motion picture machine. Stereoscope. Binocular vision.
14. Wednesday, April 12.
    Photography. The camera obscura and the eye. The photographic process. Lens correction. Color photography.

MUSEUM TALKS

Monday evenings at 7 o'clock

This series comprises informal talks, given on Monday evenings, illustrated by specimens in the Museum.

PROFESSOR SCHMUCKER

The Lower Animals

Sept. 12. The Lowest Animals.
Sept. 19. Animals that Settled Down.
Sept. 26. Animals that Build Islands.
Oct. 3. Animals without Sense of Direction.
Oct. 10. Animals that Steal their Living.
Oct. 17. Animals that are too Safe.

MISS BORDEN

Jointed Legged Animals With No Backbone

Oct. 24. The Crustlike Animals.
Oct. 31. Manylegs and Spiders.
Nov. 7. The Six-footed Arthropods.

Nov. 14. Moths and Butterflies.

Nov. 21. The Beetles.

Nov. 28. The Social Insects.

MR. LAWRENCE

Animals With a Backbone

Dec. 5. Fish: Their Adaptations, Habits and Economic Importance.

Dec. 12. Amphibians: Toads, Frogs, Salamanders, and Newts.

Dec. 19. Reptiles: Snakes, Lizards, Turtles, Alligators, and Crocodiles.

Dec. 26. No Lecture.

Jan. 2. No Lecture.

Jan. 9. Birds: Adaptations, Migration, Nesting Habits, and Food.

Jan. 16. The Lower Orders of Mammals.

Jan. 23. The Man-like Monkeys and Apes, and Man.

PROFESSOR HOWELL

Minerals, Rocks and Fossils

Jan. 30. Minerals—the Things of which Rocks are Made.

Feb. 6. Sedimentary Rocks—the Rocks which are Laid Down in Beds.

Feb. 13. No Lecture.

Feb. 20. Igneous and Metamorphic Rocks—the Rocks which have Cooled from a Heated Condition.

Feb. 27. Fossils—Plant Fossils and How they are Formed.

Mar. 6. Fossils—Invertebrate Fossils and the Great Museum at the Bottom of the Ocean.

Mar. 13. Fossils—Vertebrate Fossils: Tracks, Skeletons, and Frozen Carcasses.

PROFESSOR KAISER

Great Groups of Plants

Mar. 20. Walnut and Willow Families: Walnuts, Pecans and Hickories. Willows, Poplars and Aspens.

Mar. 27. Spurge and Pink Families: Beautiful Garden Flowers of Many Forms and Colors.

Apr. 3. Mallow and Linden Families: Hollyhocks and Marshmallow. The Explosive Sand-box and Ill-smelling Durian of the East. The Linden Tree and Its Kin.

Apr. 10. Rue Family: Garden Rue, Prickly Ash, Fraxinella. Citrus Fruits. Flax, Geranium, Nasturtium and Garden Balsam Families.

Apr. 17. Maple and Holly Families: Native and Cultivated Maples. Some Rare Species. American, European and Japanese Hollies.

Apr. 24. Myrtle Family: Tropical and Sub-tropical Plants. Useful Spices and Luscious Fruits.

GENERAL SCHEDULE OF REGULAR LECTURES

Subjects of courses in each of the four successive years constituting a full term.

ENGINEERING

1. Materials of Engineering Construction.
2. Civil Engineering Structures.
3. Roads, Railroads and Tunnels.
4. Water Supply, Sewers, Canals, Rivers and Harbors.

PHYSICS

1. Properties of Matter. Mechanics.
2. Heat and Sound.
3. Light.
4. Electricity and Magnetism.

INORGANIC CHEMISTRY

1. General Principles, Notation, Nomenclature.
2. Descriptive Chemistry.
3. Descriptive Chemistry.
4. Descriptive Chemistry.

ORGANIC CHEMISTRY

1. General Principles, Aliphatic Hydrocarbons.
2. Carbohydrates, Fats, Oils and Waxes.
3. Cyclic Hydrocarbons.
4. Compounds of Nitrogen.

ZOOLOGY

1. Invertebrate Animals.
2. Vertebrate Animals.
3. Human Biology.
4. Principles of Animal Life.

BOTANY

1. Morphology.
2. Taxonomy.
3. Taxonomy (continued).
4. Physiology and Ecology.

GEOLOGY AND PALEONTOLOGY

1. Physical Geography.
2. Physical Geology.
3. Paleontology.
4. Historical Geology.

LECTURES UNDER RICHARD B. WESTBROOK FOUNDATION

1912.—Ancient Civilization of Babylonia and Assyria. *Morris Jastrow, Jr., Ph.D.*

1913.—Conservation of Natural Resources.
Gifford Pinchot, Marshall O. Leighton, Overton W. Price, Joseph A. Holmes.

1914.—The Theory of Evolution. *William Berryman Scott, Ph.D., LL.D.*

1915.—Invisible Light. *Robert Williams Wood, LL.D.*

1916.—Aspects of Modern Astronomy. *John Anthony Miller, A.B., A.M., Ph.D.*

1917.—Heredity and Evolution in the Simplest Organisms.
H. S. Jennings, B.S., A.M., Ph.D., LL.D.

1918.—The Chemistry, Nutritive Value and Economy of Foods.
Harvey W. Wiley, A.M., M.D., B.S., Ph.D., LL.D., D.Sc.

1919.—The Origin and Antiquity of the American Indian
Aleš Hrdlička, M.D., Sc.D.

1920.—Chemistry and Civilization. *Allerton S. Cushman, B.S., A.M., Ph.D.*

1921.—Microbiology. *Joseph McFarland, M.D., Sc.D.*

1922.—Evolution of the Human Face. *William K. Gregory, Ph.D.*

1923.—The Philosophy of Sanitation. *George C. Whipple, B.S.*

1924.—The Distribution of American Indian Traits. *Clark Wissler, A.M., Ph.D.*

1925.—Structural Colors. *Wilder D. Bancroft, Ph.D., Sc.D.*

1926.—The Animal Mind; its sources and evolution. *George Howard Parker, Sc.D.*

1927.—An Interpretation of Atlantic Coast Scenery. *Douglas W. Johnson, Ph.D.*

1928.—The Science of Musical Sounds. *Dayton C. Miller, Ph.D.*

1929.—Volcanoes and Vulcanism. *William B. Scott, Ph.D., LL.D.*

1930.—Present Problems of Evolution. *Edwin Grant Conklin, Ph.D., ScD., LL.D.*

1931.—The Problems of the Origin and Antiquity of the American Aborigines in the Light of Recent Explorations. *Aleš Hrdlička, M.D., Sc.D.*

1932.—Common Sense, Science and Philosophy *John Dewey, Ph.D., LL.D.*

WESTBROOK FREE LECTURESHIP PUBLICATIONS

Can be purchased through any book-store

Ancient Civilization of Babylonia and Assyria, by *Morris Jastrow, Jr.* J. B. Lippincott Co.

The Theory of Evolution, by *William Berryman Scott.* The Macmillan Co.

Life and Death, Heredity and Evolution in Unicellular Organisms, by *H. S. Jennings.* Richard G. Badger.

Chemistry and Civilization, by *Allerton S. Cushman.* Richard G. Badger.

Fighting Foes too Small to See, by *Joseph McFarland.* F. A. Davis Co.

The Relation of Nature to Man in Aboriginal America, by *Clark Wissler.* Oxford University Press.

PUBLICATIONS OF THE INSTITUTE

TRANSACTIONS

Vol. 1.—Explorations on the West Coast of Florida and in the Okeechobee Wilderness. *Angelo Heilprin.* $2.50

Vol. 2.—Report on Fresh-water Sponges Collected in Florida. *Edward Potts.*
Notice of Some Fossil Human Bones. *Joseph Leidy.*
Description of Mammalian Remains from Rock Crevice in Florida. *Joseph Leidy.*
Description of Vertebrate Remains from Peace Creek, Florida. *Joseph Leidy.*
Notice of Some Mammalian Remains from Salt Mine of Petite Anse, Louisiana. *Joseph Leidy.*
On Platygonus, an Extinct Genus Allied to the Peccaries. *Joseph Leidy.*
Remarks on the Nature of Organic Species. *Joseph Leidy.* $1.00

Vol. 3.—Parts 1, 2, 3, 4, 5, 6.—Contributions to the Tertiary Fauna of Florida. *William H. Dall.* $15.75

Vol. 4.—Fossil Vertebrates from the Alachua Clays, Florida. *Joseph Leidy.* $1.25

Vol. 5.—Study of Hawaiian Skulls. *Harrison Allen.*
Notes on the Palæontological Publications of Prof. William Wagner. *William H. Dall.* $1.00

Vol. 6.—Selenodont Artiodactyls of the Uinta Eocene. *William B. Scott.* $1.00

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Pictographs from the Hopi Country, Arizona
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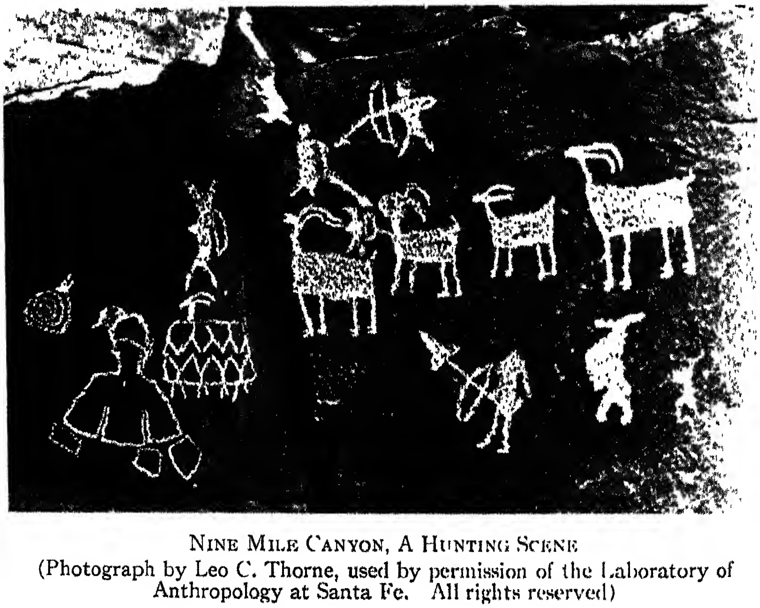


Nine Mile Canyon, A Hunting Scene
(Photograph by Leo C. Thorne, used by permission of the Laboratory of Anthropology at Santa Fe. All rights reserved)

SOME NOTES ON THE PICTURE WRITING NORTH OF MEXICO

By Albert B. Reagan, Ph.D.
United States Indian Field Service

Several systems of picture writing were being developed, or had been in use, north of Mexico when the white man came.

The ancient Pueblos and cliff-dwellers had a system of picture writing that they undoubtedly readily understood, for the bare rocks in the country of their abode are covered with innumerable pictographs and petroglyphs, but as yet no key has been discovered by our race. Consequently with our present knowledge we do not know how advanced this writing was when those people were at the height of their power. A rosetta stone is now being sought by which we can interpret many of the earlier petroglyphs, which are probably clan symbols placed on the rocks to record some great event; and such seems now to have been found, at least in part, in the petroglyphs on the rocks near Willow Springs, six miles south of Tuba City, Arizona. The glyphs here seem to record the imaginary going and coming of the spirits of the dead from this earth-shelf through the *shipapu* hole (the canyon at the junction of the Little Colorado and the Colorado) to *Shipapulima*, the underworld heaven of the Hopi-Pueblo Indians, and the Hopis' and Pueblos' coming and going to see this hole and to visit the magic salt beds in its depths. Of the characters used on the rocks here, twenty-eight have been definitely determined as clan symbols of the Hopis.[1]

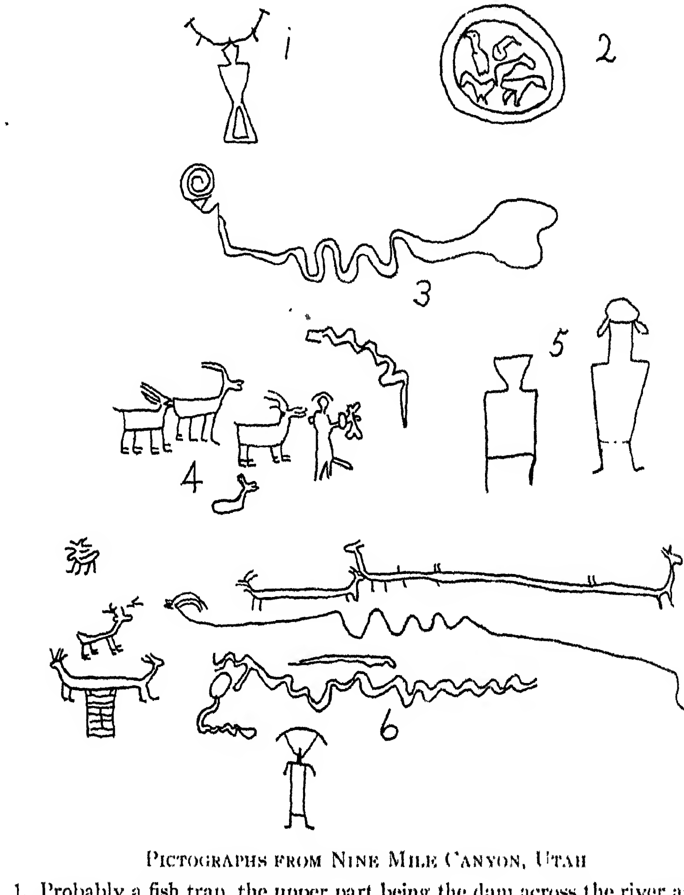
The petroglyphs of a great part of the west are concentric circles, wavy or zigzag lines, human figures, quadrupeds in general, mountain sheep, mountain goats, hands, human or bear tracks, spirals, snakes, stars, dots (probably used as counts), netting, circles connected in series, circle chains, bisected circles, connected dots, circular gridirons, sheep's horns, rectangular gridirons, cross-hatching, angular meanders, bird tracks, rain symbols, outlined crosses, concentric diamonds, parallel zigzags and series of diamonds, lizards, spoked wheels, two-edged saws, ladders, "herringbones," cogged wheels, "amoebas," concentric bands in color, pelts, many-legged insects, centipedes, mazes, horned toads, horned humans, birds, and kachina-like figures. So far, however, "any attempt to draw inferences as to meaning, age, and relationship of the petroglyphic inscriptions here is fraught with methodological difficulties. Stratification which is so useful in archaeological comparisons is lacking here. The nearest approach to it is superimposition of designs, but this has generally yielded negative results."[2]

The Indians of Idaho and adjoining territory were users of the sign language; and it would seem that they tried to put on the rocks the signs they used to convey their thoughts. Among the characters used there are long lines which would seem to indicate maps or trails. Groups of glyphs are also evidently pictures of battles over game lands; while others relate prin-

[1] See Colton, Mary Russell F. and Harold S., "Petroglyphs, the Record of a Great Adventure," Amer. Anthr., n.s., vol. 33, no. 1, Jan.–March, 1931, pp. 32–37.

[2] See Steward, Julian H., "Petroglyphs of California and adjoining States," Univ. Cal. Pub., Amer. Archeol. and Ethn., vol. 24, no. 2, p. 55.

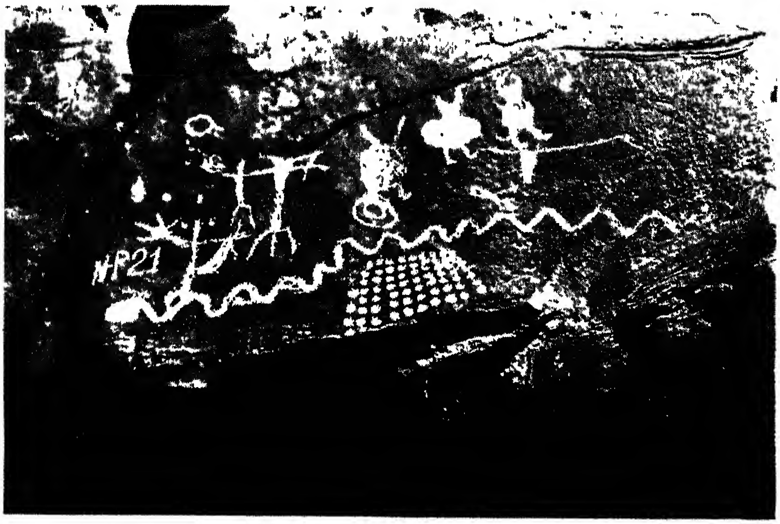
cipally to personal achievements and experiences, records of visits of individuals, trail signs, water signs, warnings, game lands, mortuary notices, religion, dreams and ceremonies. How far back these records may go is problematical; they may even include writings of the Pueblos and ancient Basket Makers. It is also uncertain as to how many years before the coming



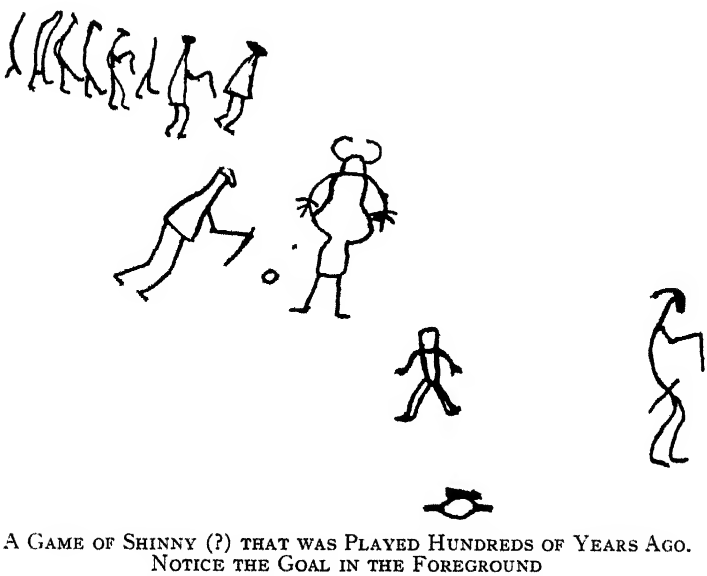
PICTOGRAPHS FROM NINE MILE CANYON, UTAH

1. Probably a fish trap, the upper part being the dam across the river and the rest, side-pockets below the dam to catch the fish that escape through the small opening in the dam. 2. Five turkeys in a corral. 3. Two snakes. 4. Four goats and a large man who is being attacked by a smaller man with a bow and arrow. 5. Two square-shouldered drawings of human beings, one of whom is wearing his hair in side locks. This drawing undoubtedly depicts Basket Maker people. 6. A plumed snake--mythical beast group.

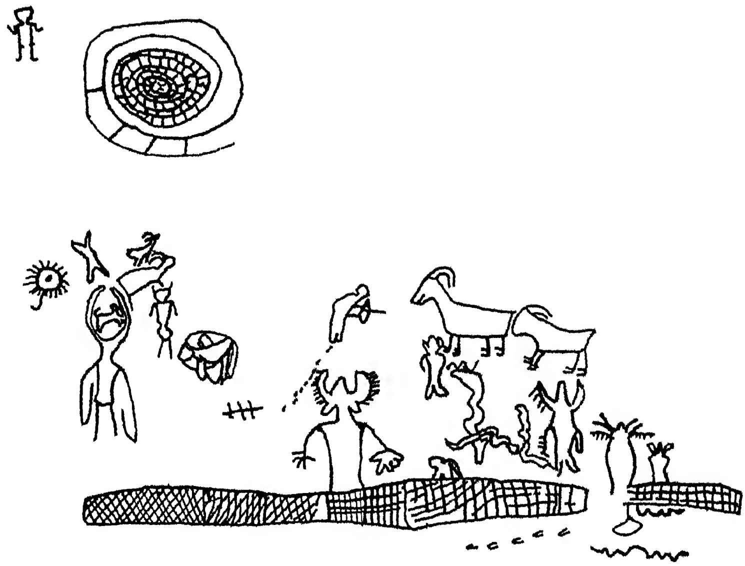
of the white adventurers the sign language was used by these Indians, some writers maintaining that it was introduced as a trade language by the trappers and traders of the early exploring fur-trading days. Some of the petroglyphs show men on horseback, even in the battles. This would show that the pictures in which they are depicted were made after horses had been intro-



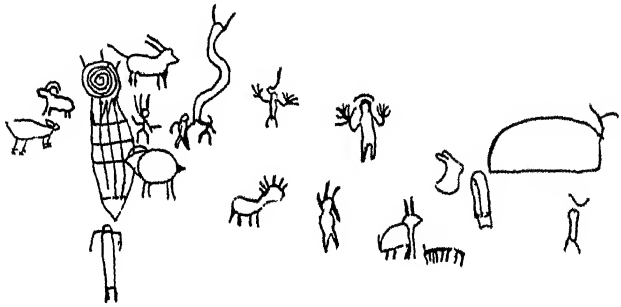
Nine Mile Canyon, East of Price, Utah
(Photograph by Leo C. Thorne, used by permission of the Laboratory of Anthropology at Santa Fe.)



A Game of Shinny (?) that was Played Hundreds of Years Ago. Notice the Goal in the Foreground
(From pictographic group N-P10 in Nine Mile Canyon, Utah)



THE ROOMED, CONCENTRIC CIRCLE GROUP
(From pictographic group N-P7 in Nine Mile Canyon, Utah)



A UINTAH BASIN SCENE
A Puebloan petroglyph in which two men are depicted as carrying the image of the horned, or plumed, rain snake

duced into America by the Spaniards in the sixteenth century.[3] A more careful study of these rock pictures, based on their interpretation through the sign-language medium, would undoubtedly bring far-reaching results.

In the Uintah Basin, in northeastern Utah, there are rock pictures of at least four ancient cultures that seem to have decipherable value, as Basket Makers, Pueblos, a people who made round-bodied drawings to represent human beings, and Head Hunters.

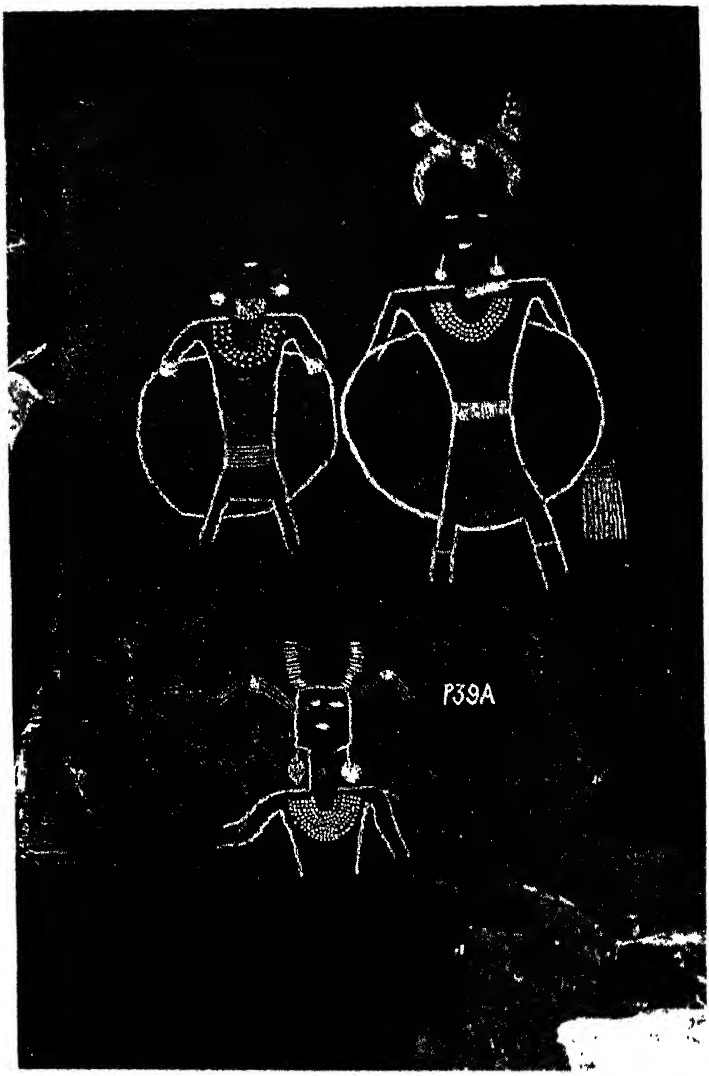
The Pueblos here entered on the scene in the dawning stage of their culture, living then in earth lodges and possessing only a crude gray pottery which they smoothed but did not decorate; and they were driven out of the region when they were yet in No. 2 horizon of their culture, soon after they had resorted to building thick-walled houses and pueblos and the erecting of

A MAZE SCENE FROM THE UINTAH BASIN, UTAH

(Photograph by L. C. Thorne, used by permission of the Laboratory of Anthropology at Santa Fe, New Mexico. All rights reserved)

cliff-houses, towers and forts as protection against an ever-encroaching enemy. From this it is concluded that they entered the region about the beginning of our era and were driven out about the time of the fall of the Roman Empire. In places their pictures are superimposed over those of the Basket Makers; and, in turn, the drawings of the other two cultures are superimposed over them, clearly showing the time succession. The Head Hunters were the last comers and they depict themselves time upon time as returning from successful raids with the heads of the vanquished foes and with women and children captives, the heads probably being only trophies of war as were scalps in several other parts of America. And some of the women captives

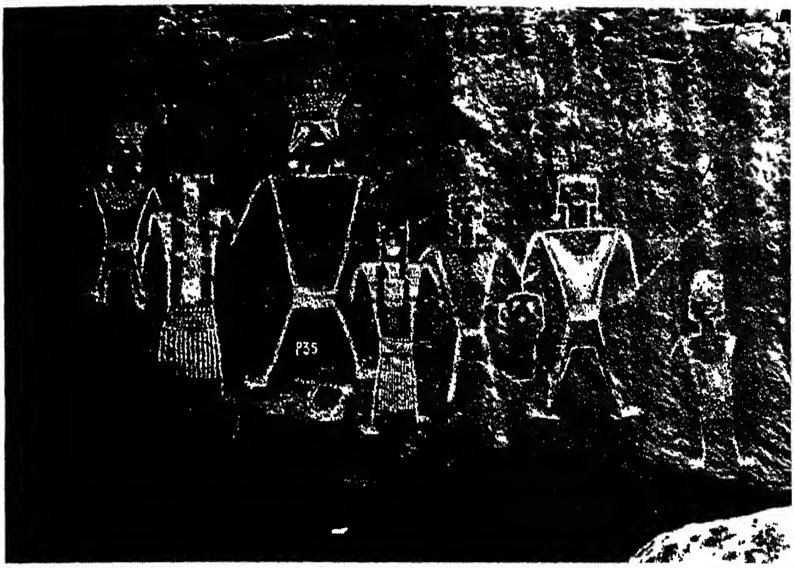
[3] Also see Erwin, Richard P., Indian Rock Writing in Idaho, Idaho State Historical Society Publication, Boise, 1930.



A Uintah Basin Scene, Utah

Square-shouldered drawn people, carrying rainbow hoop drawings, are here superimposed over a Pueblo scene of an earlier date. A Pueblo virgin with her whorled hair is shown with the right square-shouldered figure and his hoop (rainbow) superimposed over her figure. The lower figure is much betogged. The cord skirt is part of a Pueblo woman's attire; the rest of her person is too much worn to show in the photograph.

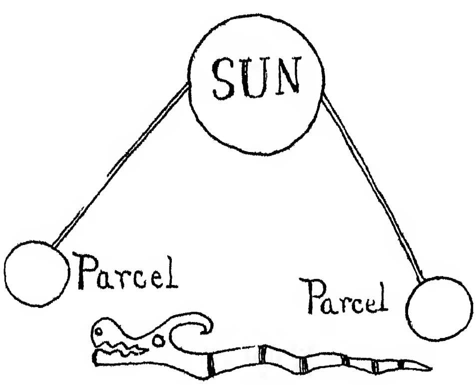
(Photograph by L. C. Thorne. Used by permission of the Laboratory of Anthropology at Santa Fe, New Mexico. All rights reserved)



THE RETURN OF A WAR PARTY

This scene is that of a war party returning with the heads of the vanquished men and with their women as captives. Notice that both of the women are wearing cedar-bark, cord skirts and that at least one of them has her hair whorled over her ears as Hopi virgins wear their hair at the present time. Notice also that one warrior and one of the captured heads are represented as having "slant eyes." It is evident that the Pueblo-Hopi people had been defeated and their women and their own heads are being brought back by the victors. And again, we are probably looking on a return of a victorious war party that made its raid years before Caesar crossed the Rubicon.

(Photograph by L. C. Thorne. Used by permission of the Laboratory of Anthropology, Santa Fe, New Mexico.)



TOMANAWIS OF CHIEF CHA-ME-TSOT OF THE LUMMI RESERVATION, NEAR BELLINGHAM, WASHINGTON, WITH A DRAWING OF THE LIGHTNING SNAKE OF THE MAKAHS

are shown with hair arranged in squash-blossom side-whorls in the identical style that Hopi maidens wear their hair at the present time.

The pictures, which are drawn in almost life size and clearly show the four cultures, appear to be in a sense narrative, each picture probably representing a narrative event —that is, the picture would call up some event with its various details. In other words, the pictures depict scenes and probably record events in the lives of the principal actors. Furthermore, at least in the case of the scenes carved or painted by the Head Hunters, it would therefore seem that a great part of them are epitaphs, setting forth the principal events of the deceased actor's life and that they were drawn as a

PICTOGRAPHS FROM THE NEZ PERCE, COEUR D'ALENE AND CAYUSE INDIAN COUNTRY IN EASTERN WASHINGTON
(Photograph by Delmer L. Powers.)

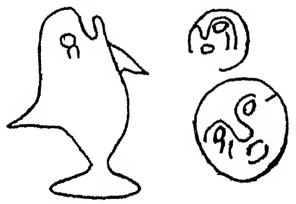
part of his death ceremony, the other glyphs of this culture, for the most part, being apparently explanations of myths and the recording of conspicuous events.

It should be added, in correlation, that the head hunters, above, were a peripheral people who had many customs of the Basket Maker III level, as well as some of the Ute-Chemehuevi and other Shoshonean peoples. In time, they took on the Pueblo culture and became the Pueblo No. II people of the Fremont stage of that culture age, as given by Morss[4]; and for a con-

[4] Morss, Noel, "The Ancient Culture of the Fremont River in Utah," Papers, Peabody Mus. Archaeol. and Ethn., Harvard University, vol. 12, no. 3, Cambridge, 1931.

siderable time, their possessions extended along Green River and its tributaries from probably far into Wyoming southward to the Fremont (Dirty Devil) River in southern Utah. They, however, were out of the main stream of Southwestern Pueblo culture. It would seem that they passed from the "savage" state directly into No. II culture without passing through No. I culture stage, due, probably, to their intermarriage with (or their absorbing) the Uintah (Willard-Beaver) culture Pueblos who had then passed over the threshold into No. II stage of Pueblo culture. However, so far as present obtainable data show, they seem never to have stood much closer to the Orthodox Pueblo cultures of the Southwest, of their time, probably about 570 A. D., than the Navajos do to the present Hopi-Pueblo cultures.

Once when at the "portage" on the Lummi Indian reservation, across the bay from Bellingham, Washington, the writer visited the ruins of an old give-away ("potlatch") dance hall. A row of column posts, each about two feet in diameter, marked the site. Nothing else of the great hall was left but a ridge of earth that marked the outer boundaries of the building when intact. On examining the columns he found that each post had a carving on it facing the inside of the hall, and that the carvings were similar. He gives herewith a reproduction of these drawings. He also inquired among the Indians for an explanation of this totem *tomanawis*, and the following was given him by William McClusky, the Indian judge of the reservation.



Rock Carving at Ozette Indian Village, on the Coast Southwest of Cape Flattery, Washington

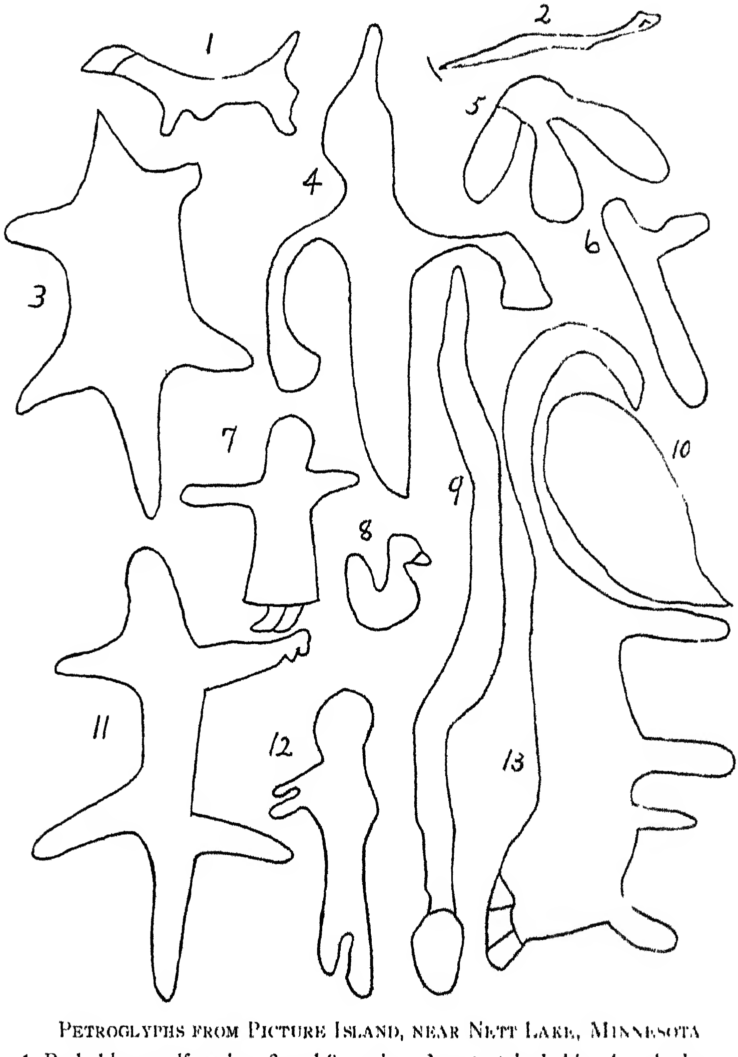
"Chief Cha-me-tsot once owned the 'potlatch' house at the portage. The drawings on the totem posts there are his *tomanawis*. The sun, carrying a parcel of valuables in each hand, came to him in a dream and said: 'Your storehouses (trunks) will always be full. You will therefore give two more feasts than the average chief.' Custom had established the rule that the ordinary chief should give three feasts in a lifetime, that is, feasts of the *potlatch* type. So Chief Cha-me-tsot built the *potlatch* house and carved his *tomanawis* on its totem posts. He then gave five feasts, two more than the average, as the sun in the vision had commanded him."

Similar drawings are found in eastern Washington, usually cut on some smooth rock face. One, a picture of which is here given, depicts the sun carrying two parcels surrounded by various animals. The sun in this case would seem to represent a chief who is going to give two extra *potlatches*, the animals represented being the totems of the clans of the tribe invited to the feast.

A rock carving at Ozette on the Pacific coast, southwest of Cape Flattery, Washington, a drawing of which is here given, depicts a fish, the half moon, and the full moon, the position seeming to indicate that the fish is caught between the half and the full moon, which was probably the meaning intended.

In Nett Lake, near the Indian village of the same name, not far from Orr,

Minnesota, there is a small island, known as Picture Island. It is low and its northern and eastern surfaces are polished rocks dipping into the placid water, the polishing having been done by glacial action during the Ice Age.



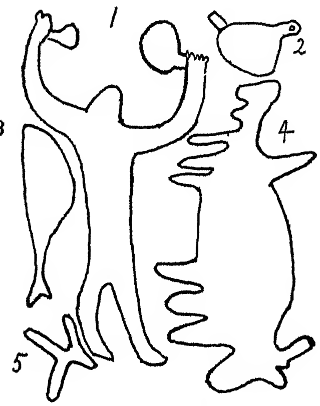
PETROGLYPHS FROM PICTURE ISLAND, NEAR NETT LAKE, MINNESOTA

1, Probably a wolf or dog; 2 and 9, snakes; 3, a stretched skin; 4, a duck represented as rising from the water; 5, a bird track; 6, a tomahawk; 7, a woman; 8, a duck; 10, a leaf; 11, a lizard; 12, a man; 13, a mountain lion (?).

In these sections its rocks are covered with crudely made pictographs of human beings, dance scenes, and outlines of the animal gods worshipped by the men who made the pictures. The drawings seem to be similar to those at Pipestone, Minnesota, which are known to have been done by the Sioux;

and the Bois Fort Chippewas in the vicinity say that their people did not make the "rock pictures."

As to the purpose for which the drawings were made and made in such numbers, it is found that the island surface has a hollow sound when one is walking over it, for which reason the Chippewas call it "Drum Island," believing it to be the home of their deities, for the gods are believed by them to live in a "drum place." Furthermore, they offer tobacco and articles of clothes and food to them there. They say: "The polished rock area is hollow beneath; and, on walking over it, it gives out a hollow, drum-like sound, for which reason it is considered sacred by us. It is the home of our *manido*, and whenever we go on it they drum to tell us we are on sacred ground. Consequently, to appease them and keep their goodwill and to have our lives more happy we place 'medicine,' tobacco, and smelling herbs in the crevices and the 'hollow place' in the rock as an offering to them."



PICTOGRAPHS FROM PICTURE ISLAND, NEAR NETT LAKE, MINNESOTA

1, A musician beating a drum; 2, a spruce hen; 3, a fish; 4, a mythical beast; 5, a bird track.

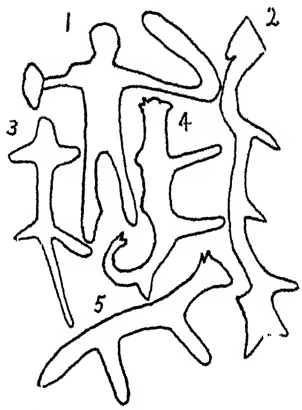
It is also very likely that the original Indians of the region had a similar idea about this island and that is why they drew the crude religious scenes on its rock face. It is a fact that in the old times, and even now, God and the drum have a close relationship among the Indians in this northern country. In the old times there was a drum house; and someone was always left to keep charge of the drum. To lose it was to incur the enmity of their god. Their reverence for the drum has had influence, no doubt, in causing them to worship the "drum place" on this island and to honor it with their sacred drawings.

When asked about this island and its pictographs, some of the very oldest medicine men have related this legend:

"The first Chippewa Indians in the region came to Pelican Lake through the Vermillion-Pelican river route from Vermillion Lake. On arriving there, they explored it; and, on coming to what is known as Farmer John's Landing

near its western terminus, they found a little stream leading northwestward. This they followed to its source, and then after going over a little sandy knoll, they came to the head waters of the little creek that flows westward through the Austrian homesteads to the northeast lobe of Nett Lake. Then, on coming in sight of that lake, they returned to Pelican Lake and gave word to the other Indians of what they had discovered, after which a day's rest was taken. Then a large company of Chippewas passed over this portage route to Nett Lake by way of Lost Creek, carrying their canoes with them.

"They had been canoeing only a few minutes in that lake when they came in sight of Picture Island, and lo, it was swarming with a multitude of beings that were half sea lion and half fish. On their approach, these became panic stricken and, fleeing to the west side of the island, took to the water and swam with all speed across the lake and up a little creek that leads southward. Reaching the head of this stream and still being pursued, they dove down



DRAWINGS FROM PICTURE ISLAND, NEAR NETT LAKE, MINNESOTA

1, A musician with something like a tamborine with which he is keeping time; 2, the feathered lightning; 3, a salamander; 4, a mythical beast; 5, a wolf.

into the earth; and now the water bubbles forth from the place where they disappeared, a site still held sacred by our people. On coming to the island, the canoemen paddled around it. Then by the track of the muddied water they pursued the beasts across the lake and up the creek till they found where the earth had swallowed them up as though they had been caught in a net. Since then we have called the lake 'Netor as-sab-a-co-na' (Nett Lake, that is, the lake with a net). Then when our people had returned from the pursuit they found these pictographs on the island. They are the writings of those half sea lion half fish beings."

An interpretation of this myth seems to be as follows: The battle of Elbow Falls in the Vermillion Lake region to the eastward had been fought between the Bois Forts and the Sioux and the latter had suffered a crushing defeat. Some time later the victorious Chippewas crossed over the portage between Pelican and Nett Lakes, entering that body by way of Lost Creek. A party

of Sioux had gathered on Picture Island probably for protection. On seeing the Chippewa warriors in such numbers, they became panic stricken and fled across the lake southwestward and on up the little creek mentioned, which is the head of the overland trail from Nett Lake to the Bowstring country, where, no doubt, the Sioux fled. The Chippewas pursued them to the head of the stream where it has its source in a number of bubbling springs. That the pursued had had the earth swallow them up and that they were half sea lion and half fish beings was, no doubt, invented to account for their precipitous flight and disappearance.

When the white people came to America they found the Chippewa (Ojibwa) using a crude writing, which, had America been left to develop its own civilization in its own way, would, no doubt, in time, have equalled the Mexican-Mayo systems if not surpassed them.

In no other tribes north of Mexico was picture writing developed to the advanced stage that it reached among them and the Delawares. This writing was favored by the barks of the region, birch bark being the principal bark used; and cartography, clan symbols, winter and summer counts, number counts, medicinal formulas and songs, tribal history and myths, and lodge rituals were probably inscribed and handed down from generation to generation. One old medicine man at Nett Lake, Minnesota, has over forty song birch-bark parchments; and, in singing from them, he holds them before him much as we do a book.

This system was being developed by the shamanistic-medicine fraternity, and one wonders if the other writing systems of the world were not thus originally begun.

While curio collector for the National Museum (the then Victoria Memorial Museum) of Canada, 1909–1914, the writer obtained many birch-bark scrolls of the Bois Fort Chippewas of Minnesota, including migration treks from the Atlantic Ocean to The Lake of the Woods, and rituals of the Grand Medicine Lodge and other ceremonies. Two of the parchments obtained are given herewith. The long lines indicate a pause in the song; while the Indian equivalent follows the English translation, in parenthesis.

PETE MARTIN'S PARCHMENT, A SONG

1. Is the division line between stanzas.

First Stanza

2. I am the daylight road.
3. I come out on the ground to dance. (Aun-tshnabe che-no-ke-ah-king.)
4. I sing to your gods; I sing to God. (To-bish-ko-ai-yah-wit aun-ge-man-ne-wy-ah.)

The meaning of the whole stanza seems to be: I come out to sing and dance to my god in the early morning.

Second Stanza

5. I stand up on the ground. (Nan-nebo-yan-ah-king.)
6. I can "scale" on the water (not swim). (This is the otter verse.) (Bay-bah-mah-ay aun-o-mah-ne-bing.)
7. I can go in all wigwams. I am the god that is everywhere. (Kay-bay-bin-de-gay aun-wiggewam.)

8. When I come out I hang (myself) up in the sky (reverting back, no doubt, to the sun's being considered as the chief deity and his daily crossing the sky). (Nah-gohd-deg-geshick mam-mo-ke-yan.)

The meaning of this stanza appears to be: I am God. I am everywhere. I go into all wigwams. I can float on the surface of the water. I also live in the sky above.

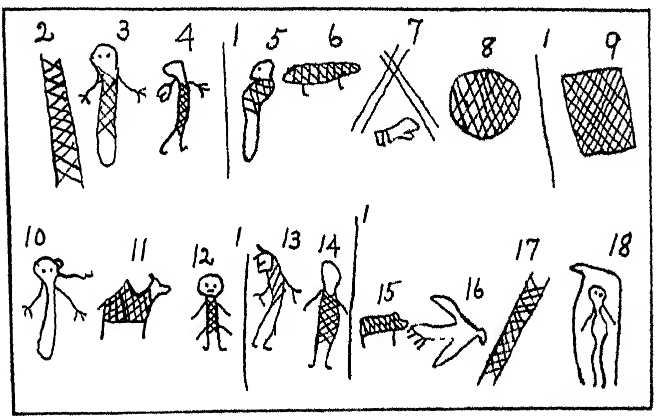
Third Stanza

9. In the center of the earth is the home of our gods. (Nah-nah we-eunie man-ne-do we-yah.)

10–11. We walk around (repeated). (10. Aun-no-say yah-nah-king. 11. Wy-no-say yah-nah-ah-king.)

12. I walk. (Pon-dos-say yah-ne.)

The meaning of this stanza is: I walk, we all walk on the ground, but the home of our manidos (gods) is in the center of the earth.



PETE MARTIN'S PARCHMENT

Fourth Stanza (reverse side of parchment)

13–14. I walk right on (repeated), meaning, I, the god, am always walking about. (A-no-say-aun, repeated.)

The meaning of this stanza appears to be: (The gods being willing) I will proceed; or, what seems more probable, I, the god, am always walking about, as given above.

Fifth Stanza (reverse side of parchment)

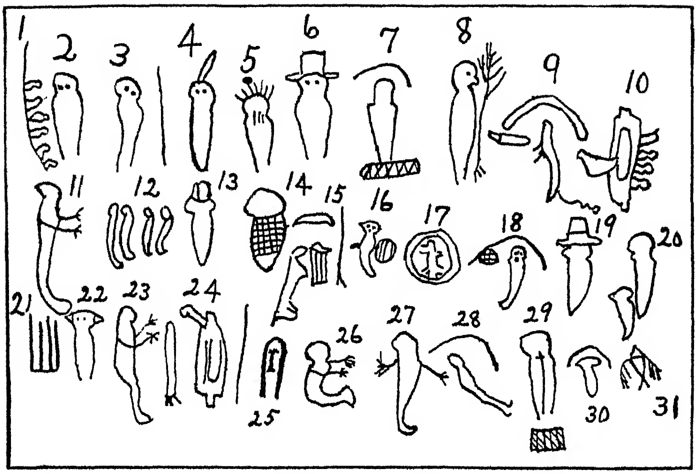
15. I walk right on. (A-no-say-aun.)

16. I fly. (Bay-baum-say on.)

17. (No equivalent.)

18. I am walking around. (Nenah-ah-king pay-mo-tasy-yan.)

The meaning of this stanza is: I am God. I walk where I please. I walk around everywhere. I fly everywhere. I am God.



FARMER JOHN'S PARCHMENT

FARMER JOHN'S MEDICINAL BARK PARCHMENT

Note: A straight line is a mark used to indicate a long pause in the song. Each figure also represents a stanza in the song, which both in parts and as a whole is often repeated.

1–3. My truth is long. My words and truth are strong. My heart is true, and my words and truth are strong. (A mah-mash ke-da-a-way.)

4. (The dance begins on this division, everyone rising and dancing.) Manido, manido, manido.

5. Our Father, why is he the manido. All he uses is his word and this makes him God. (Ko-se-nan jun-i-nedo.)

6. The chief. He is the chief. He is the chief. He is God.

7. The world, the world, the universe, light, air, water. (Nennan-bay-no-tany-ge-gay-hay.)

8. I am talking about the trees and the land.

9. I am everywhere when I ask for something to eat in the sky.

10. (This figure represents the East or Morning Song and Dance.) We're dancing through the morning dance hall (wabeno-no-weit).

11. I am looking for a camp (wigwam) that is in the East. (End-do-nay-o-mug (I am looking) wah-bum-no-o-king wiggewam.)

12. This figure represents the cactus plant, which is considered as "big" medicine among the Chippewas. They assert that the manido planted it as the symbol of life and that it has always kept increasing from that first plant; and life among men increases in the same way. The figure has no English equivalent.

13. The figure says: "I feel happy and laugh that I am called to 'make song' (at the medicine lodge dance); and a spirit came after me who also felt so good when he arrived at the place of meeting that he laughed, too."

14. I want to listen to what the gods say because I know their word is true.
15. They hear me all over the land and even up in the sky. (The Indians do not dance while this verse is being sung.) (Nah-wah-king-a-dayboway king sho-king-o-day-bo-way.)
16. Do you hear me, my son? Do you hear the surf in the rolling wind?
17. This figure represents the water around the earth. The spirit says: "I rise out of the water."
18. I walk till morning. (Hay-ne-wah-bah no-sa-sa.)
19. I am the "out-talker." (Shah-gah-gah-da-ha ogemah oh-he-og he-ohe-ohe.)
20. I am hiring some one who belongs to this lodge. (Han-dah-no-nah oban-no skah-bay.)
21. (Morning song.) I am daylight. (The Chippewas worship Daylight as Wabeno, the Manido of the Morning.) (Ho-waun-ne-gah-bow.)
22. The gods (manido) are asking me to come. (Non-dah-me-go menido'k wabenoke.)
23. Daylight will take me home.

On account of the sudden death of the aged Farmer John, age 104 years, the writer obtained a translation of only part of the parchment.

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